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AMETHYST: ITS NATURE AND ORIGIN*

AMETHYST is a variety of crystalline quartz which, instead of being colourless and transparent like the ordinary form of rock-crystal, exhibits a beautiful purple colour, in consequence of which it has been esteemed as a gem-stone since ancient times. Mineralogists have naturally been much interested in the question of the origin of this colour. Problems of the same nature arise in regard to numerous other minerals and it was customary in the past to explain the colour in such cases as due to impurities assumed to be present in the material and diffused through it in an atomic or a colloidal form. A different view regarding the origin of colour in many minerals has latterly been gaining favour, namely, that it is a consequence of defects in the regularity of structure such as would be caused, for example, by the crystal having been subject over long periods of time to radiations traversing its substance. Explanations along one or the other of these two lines are to be found in the extensive literature concerning amethyst, but it can scarcely be claimed that they are based on evidence of a convincing nature. Still another view regarding amethyst which for a long time held the field is that it consists of quartz in which layers of the right-handed and left-handed varieties alternate. Why such alternation should result in colour is a question which was left unanswered.

The problem of amethyst has been under investigation at my Institute in Bangalore during the past year and conclusions regarding the nature of this material have been reached which are different from anything which has been so far suggested. They are based on the results of fact-finding research on those properties of amethyst which appeared to us most likely to throw light on its physico-chemical constitution.

The first series of studies undertaken by Mr. A. Jayaraman and myself were precise measurements of the density of amethyst quartz. For such measurements to have scientific value, it is necessary to work with selected material free from cracks, inclusions and visible impurities. Accordingly, cut and polished gem-stones believed to be of Ceylonese

* Presidential Address delivered at the Annual Meeting of the Indian Academy of Sciences held at Belgaum on the 26th of December 1954.

origin were used for the determinations. The specimens employed varied notably in their depth of colour. Differences of the order of one or two units in the third decimal place were indeed noticed in their densities, but such differences exhibited no correlation with the depth of the colour of the specimen; neither did the values differ significantly from that of colourless quartz.

Careful studies have also been made regarding the behaviour of amethyst in magnetic fields. Quartz is diamagnetic, and exhibits a very feeble diamagnetic anisotropy. Metallic oxides such as those of manganese or iron to which the colour of amethyst has been attributed in the past are highly paramagnetic and hence, if present, might be expected to reveal themselves by an altered magnetic susceptibility. Here again our results were entirely negative. All our amethyst specimens were diamagnetic and their susceptibility showed no significant variations from that of colourless quartz.

The next property investigated was the scattering of light in its passage through the solid. As is well known, this is a severe test of the regularity of the structure of the material and of the absence of inclusions, the latter, if present, revealing themselves immediately by a largely enhanced intensity of light-scattering. Clear quartz of the best quality does indeed exhibit light-scattering, but this is extremely feeble. In smoky quartz, on the other hand, a Tyndall effect is very conspicuous. But in amethyst no such phenomenon is observable. The difference is illustrated in Fig. 1 in which the tracks of a beam of sunlight in smoky quartz and in amethyst are exhibited side by side, the specimen in each case being immersed in a cell containing benzyl alcohol to avoid refraction effects.

FIG. 1. (*a*) Smoky Quartz; (*b*) Amethyst.

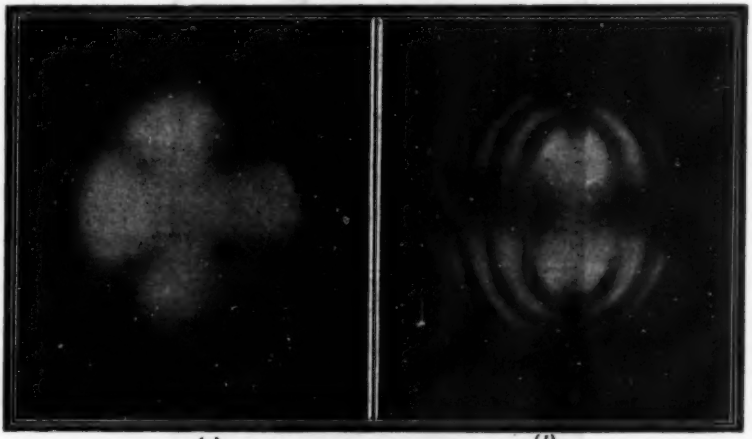
Thus we are led to the view that amethyst is a crystal with a regular structure and that the cause of the colour is to be looked for in the ultimate constitution of the crystal itself. This view is independently confirmed by the results of research in two other and quite different directions. The first is a study of the X-ray diffraction by amethyst carried out by Mr. Jayaraman and myself, and the other, a detailed investigation of its optical properties by Mr. S. Pancharatnam. I shall now proceed to summarise the findings reached.

In view of the close association of colourless quartz and amethyst as found in nature, one could scarcely expect to find any readily measurable differences in the spacings of their three-dimensional crystal lattices. What we have to look for are differences in the electronic distribution and therefore also the reflecting

powers for X-rays of the lattice planes in the two crystals. To establish the existence of such differences by the usual methods followed in X-ray structure determination would obviously be laborious and might even be infructuous. We have therefore employed a method which has proved itself to be both simple and effective. The section-plate of amethyst finally chosen for the study was cut obliquely to the optic axis of the quartz and by etching tests was ascertained to be free from either optical or electrical twinning over its effective area. It however exhibited a pattern of colour bands and colour sectors of the kind almost invariably to be seen in amethyst. The section-plate was irradiated by an X-ray pencil over its whole area and gave a Laue pattern in which each Laue spot was itself an extended picture of the crystal. It was found that the Laue spots also exhibited the features optically observable in the section-plate but in a very different way in the different spots, thus clearly showing that the variations in the colour observed over the area of the plate correspond to variations in the X-ray reflecting power which are different for the different lattice planes, as is to be expected on the foregoing view regarding the nature of amethyst.

The optical investigation by Mr. Pancharatnam has also yielded highly significant results. They may be summarised by the statement that amethyst is optically biaxial, that it exhibits trichroism and that these two properties taken together show amethyst to possess only monoclinic symmetry instead of trigonal symmetry as in the case of colourless quartz. The studies have also revealed that the diad axis of monoclinic symmetry coincides with one of the three electrical axes of the associated quartz. The latter is different for the three colour-sectors usually observed in a section-plate of amethyst, their diad axes being inclined to each other at an angle of 120°.

Whereas it has hitherto been supposed that amethyst exhibits a single absorption band in the green region of the spectrum, Pancharatnam has found that there are three different absorption spectra differing enormously in the strength as well as in the position of the absorption band, corresponding to the vibrations along the three colour axes within the crystal. The weakest of the three absorptions is for vibrations along the diad axis; the absorption maximum for it is near 5000 Å and the transmitted light is light orange in colour. The two other colour axes lie in a perpendicular plane and make angles of about 45° on either side of the trigonal axis of quartz. For one of them the absorption is particularly intense and is centred round 5250 Å, the transmitted light being a deep reddish purple. For the third axis, the absorption maximum is near 5750 Å and the transmitted light is blue in colour.



(*a*) (*b*)

FIG. 2. (*a*) Idiophanous figure; (*b*) Biaxial figure

Figs. 2 (*a*) and (*b*) respectively are photographs of the so-called idiophanous figure of absorption exhibited by amethyst in convergent unpolarised light and of its biaxial figure as seen between crossed polaroids. The former figure was photographed in the green monochromatic light of a mercury lamp and

the latter in deep red light, the crystal in both cases being viewed along the trigonal axis of the quartz.

Very small and not improbable displacements of the silicon atoms along the electric axes on which they lie would suffice to alter the trigonal symmetry of colourless quartz to the monoclinic symmetry of amethyst. The accompanying deformation of the oxygen tetrahedra surrounding each silicon atom would offer a pathway to the explanation of the pleochroism exhibited by amethyst. We shall not pause here to discuss these points in further detail, but will pass on to consider the very interesting question as to the circumstances in which silica crystallises as amethyst instead of as colourless quartz. The study of a great number of specimens collected from near Hyderabad City in South India points to certain conclusions regarding this matter. A feature very commonly observed in the individual specimens is that a region of intense colouration is observed separated from another which is comparatively free from colour by internal planes parallel to the external rhombohedral faces of the crystal. X-ray shadowgraphs of the specimens disclose that along the boundary between these two portions of the material, there is invariably a deposit of fine particles which chemical examination reveals to be ferric oxide. The conclusion is thus almost irresistibly suggested that amethyst is formed from silicious material containing ferric impurities and is consequent on the progressive elimination of these impurities during the growth of the crystal. At some stage in the process, the impurities separate out into distinct particles, and then cease to play any further role in the crystallisation, which accordingly continues as clear quartz. Figs. 3 (*a*) and (*b*) illustrate the foregoing remarks. The former is a section-plate cut perpendicular to the trigonal axis; the hexagonal ring containing the ferric oxide particles is very conspicuous and surrounds the

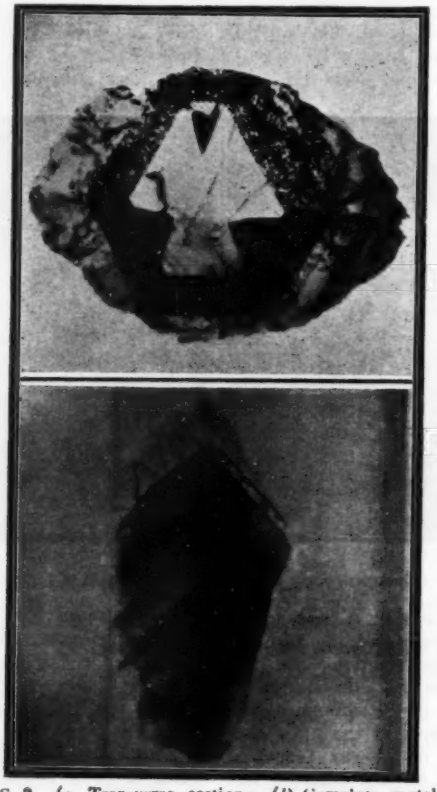


FIG. 3. (*a*) Transverse section; (*b*) Complete crystal.

inner region of quartz in which the three colour sectors adjacent to the three of the rhombohedral faces are clearly seen. Fig. 3 (b) is a picture of an entire small crystal of amethyst immersed in benzyl alcohol and viewed transversely by sodium light. Regions of colourless and coloured quartz are clearly seen in the picture, separated from one another by a sharply defined boundary which carries a dark deposit of ferric oxide.

C. V. RAMAN.

PRINCIPLES OF OPTICAL ENGINEERING*

IN unravelling the mysteries of both the atomic and the astronomical worlds, no branch of physics has played a greater role than optics. But for the development in precision optical technique which has enabled the construction of spectrographs, microscopes and telescopes, our knowledge of the physical world would not have been what it is. The optical instrument, instead of being merely a laboratory appliance, has crept into the field of mechanical engineering where the highest precision is attained only by optical devices. In aerial surveying, in accurate artillery, in fine art photography, in cinematography, in biological investigations, and in a variety of branches of human activity, optical equipment is becoming more and more predominant. From all aspects of scientific advancement, there is an increasing demand not only for a larger and larger number of new optical components, but also for improved techniques in the attainment of greater perfection in the production of these components.

It is however surprising that the literature on such an important subject as optical workshop technique is so meagre. This is probably due to the fact that manufacturers in this line were reluctant to part with their technical secrets.

The foremost in the field to get out of this traditional reticence was Charles Deve with the publication of his classical work "Travail des Verres d' optique de Precision" in 1938. The book was written with a double purpose—firstly, as a text for trainees in optical workshop principles and, secondly, as a book of reference for works managers and senior workmen. This treatise was found to be of such importance, that two more editions were brought out even during the most difficult conditions of World War II. M/s. Adam Hilger got it translated into English, and the volume under review is the second English edition of the book published by them.

From the fundamental notions of glasses and their faults, of abrasives and their gradations, of tools and their proper uses, to the most difficult art of obtaining and testing of optical components of the highest precision, the book covers the entire range of the technique of workshop optics. Deve has, for the first time, developed a coherent theory of surfacing, from which he deduces rules for workshop procedure, a practice which has been hitherto based merely on experiment and experience. It is this theory that enabled solution of a number of unsolved optical problems including the very complicated production of perfect cylindrical surfaces. In this work, precision optical technique, which was considered to be an art and a monopoly of the gifted few, is developed and treated as a scientific subject and made available to all who choose to take to this line. All aspects of manufacture of optical components including grinding, polishing, centering and edging, as well as of the allied aspects of cementing and metallising are treated in a clear and lucid manner.

An important addition in this edition of the book is the production of aspherical surfaces and contact lenses, achievements which were outstanding for generations. There is no aspect of the subject that is not dealt with, excepting that of the treatment of crystals, the technique of which could have been described in greater detail. Probably that was not in Deve's line of work, nor was he spared to live to contribute to the latest developments in this.

In the words of Ch. Fabry, who was Deve's patron and guide, "the working optician, as well as the apprentice, the foreman and the technical directors will find in this book ample matter for self-instruction and although they find difficulty in properly assimilating certain parts, will be well repaid for their pains, by a more complete understanding of a difficult art, one of the most beautiful that there is".

Hilgers have done a distinct service to the English-knowing scientists by bringing out this translation, which is a faithful reproduction of the original.

I. RAMAKRISHNA RAO.

* *Optical Workshop Principles*. By Charles Deve. 2nd English Edition. Translated by T. L. Tippcell. (Hilger and Watts Ltd.), 1954. Pp. xxiv+436. Price 42 *sh*.

NEW MICROFORAMINIFERA FROM THE ORBITOLINA-BEARING ROCKS OF TIBET AND BURMA*

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RECENTLY, while engaged on a monograph of the orbitolines found in India, Pakistan, Tibet and Burma (to be published in the *Palaeontologia indica*), the authors' attention was drawn to a number of foraminifera of minute size occurring in association with these orbitolines. Although some of these microforaminifera possess the general pattern of known genera of much larger size, absence of agglutinisation in the strict sense of the term which characterises most of their larger counterparts, proves that the apparent parallelism is no evidence of genetic relationship; also, that their dwarfism is not related to such factors as food, temperature of water, chemical composition, pH concentration, light, etc., because the associated larger foraminifera, consisting mainly of species of *Orbitolina*, are all of normal size. The dwarfism of the microforaminifera is thus inherent in the forms and quite independent of external stimuli and environment. Microforaminifera that would pass through a mesh of the size normally used for separating foraminifera have already been isolated from Tertiary rocks and recent faunas by Hoffmeister and Berry[1] and Wilson and Hoffmeister[2] while the causes of dwarfism have been discussed by several authors, among them Preston Cloud,[3] Dawson,[4] Kidder and Stuart,[5] Kidder, Lilley and Claff,[6] Lalicker,[7] Moore[8] and Scott.[9]

It was very clear that dwarfism of the microforaminifera briefly described below could not have been produced by the above mentioned factors. New generic and species names have, therefore, been proposed for them. Further work on the forms occurring in all the *Orbitolina* horizons reviewed in our monograph referred to above, is in progress.

Descriptions of the genotypes supplement the brief generic diagnoses here given. Further details are being given in a more exhaustive paper. Since the exact relationships of the genera here described are uncertain, they have not been assigned family position.

Genus *Yanbonia*, nov.

Genotype *Yanbonia moniliforme*, sp. nov.

Generic Diagnosis.—The only known species is uniserial; chambers bulbous with aperture situated centrally. For further details see description of the genotype below.

Description of Genotype.—Test uniserial, thick-walled, free, elongate, tapering towards the initial chamber; chambers subspherical, arranged in a rectilinear series; sutures straight, at right angles to the axis. The aperture appears to be terminal judging by a change in the contour along the median line of the later formed chambers.

Dimensions.—Maximum length, ·5 mm.

Age.—Cenomanian; U. Burma.

Genus *Kutaungia*, nov.

Genotype *Kutaungia cretacea*, sp. nov.

Generic Diagnosis.—Forms initially biserial, becoming uniserial in later stage. The only known species possesses three subdepressed chambers in the uniserial stage.

Description of Genotype.—Test biserial in the earlier stages, becoming uniserial later; free, elongate, tapering gradually; biserial stage consisting of three to four chambers, with a solitary, more or less circular chamber initially, which might be the proloculum. Uniserial stage consisting of three chambers, which number is constant both in the Burmese and Tibetan specimens. The uniserial chambers are flattened and the sutures are more or less at right angles to the median longitudinal axis; aperture not visible.

Dimensions.——Maximum length, ·2 mm.

Age.—Aptian-Cenomanian; U. Burma.

Genus *Hukawngia*, nov.

Genotype *Hukawngia problematica*, sp. nov.

Generic Diagnosis.—Forms initially coiled, becoming uniserial in later stages; chambers subdepressed; the uniserial stage consists of four chambers in the only known species.

Description of Genotype.—Test free, early chambers planispirally coiled, later ones uniserial and rectilinear. There appear to be five to six chambers in the coiled portion; aperture not observed.

Dimensions.—Of the two specimens, one measures ·2 mm. and the other ·3 mm.

Age.—Cenomanian; U. Burma.

Genus *Irrawaddia*, nov.

Genotype *Irrawaddia trigonalis*, sp. nov.

Generic Diagnosis.—Forms biserial with chambers increasing more or less rapidly in size in later stages, producing, in some cases (as in the genotype), a sharply triangular outline in section.

Description of Genotype.—Test free, elongate, increasing rapidly in later growth stages; arrangement of chambers typically biserial; sutures straight in the early stages, becoming more or less incurved obliquely later.

* Published by permission of the Director, Geological Survey of India.

Dimensions.—Maximum length, ·5 mm.

Age.—Cenomanian ; U. Burma.

Irrawaddia tibetica, sp. nov.

Test free, elongate, tapering, chambers biserial throughout, sutures run oblique to the axis. There are six to seven chambers in each row ; aperture not observed.

Dimensions.—Maximum length approximately, ·25 mm.

essential characters of the genus. It is widely distributed geographically having been found in areas as far removed from each other as Khan-Sang La, in Tibet and Maingtha Chaung and Ku Taung, in Burma. This wide geographic distribution is likely to prove of great value in correlation.

Dimensions.—Maximum length, ·6 mm.

Age.—Aptian-Cenomanian ; U. Burma.

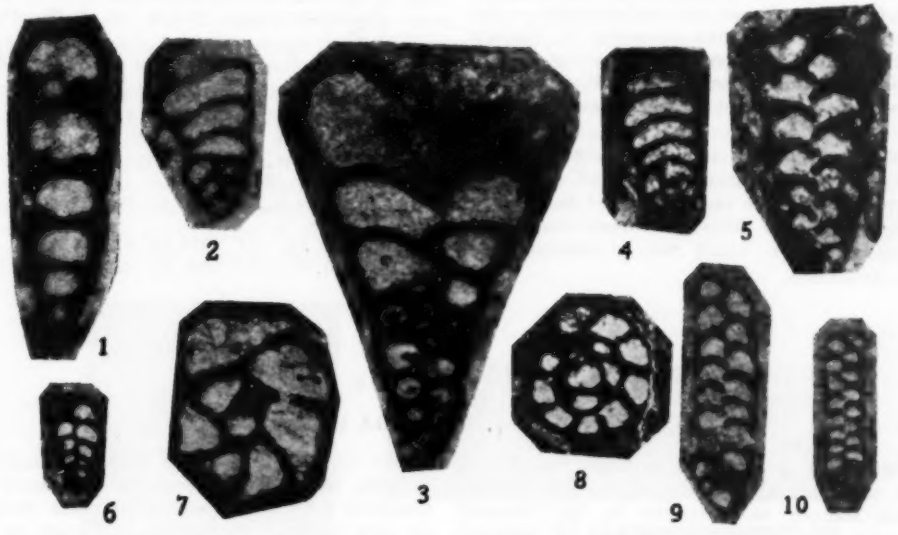

FIG. 1. *Yanbonia moniliforme*, gen. *et* sp. nov., × 100. FIG. 2. *Kutaungia cretacea*, gen. *et* sp. nov., × 125. FIG. 3. *Irrawaddia trigonalis*, gen. *et* sp. nov., × 120. FIG. 4. *Hukawangia problematica*, gen. *et* sp. nov., × 125. FIG. 5. *Mesania tibetica*, gen. *et* sp. nov., × 125. FIG. 6. *Irrawaddia tibetica*, sp. nov., × 68. FIG. 7. *Kyatsokia tibetica*, gen. *et* sp. nov., × 140. FIG. 8. *Kyatsokia multilocularis*, sp. nov., × 105. FIG. 9. *Mesania vermiforme*, sp. nov., × 124. FIG. 10. *Mesania kutaungensis*, sp. nov., × 45.

Age.—Aptian-Cenomanian ; Tibet.

Genus *Mesania*, nov.

Genotype *Mesania vermiforme*, sp. nov.

Generic Diagnosis.—Forms biserial (rectilinear or conical) with chambers of more or less uniform size, except in early stages ; sutures concave towards the initial chamber, as a rule.

Description of Genotype.—Test free, narrow, elongate, straight, biserial throughout, of uniform width except in the initial stage ; nine to ten chambers constitute each row ; sutures deeply incurved and uniformly thick ; initial portion of shell slightly conical.

Dimensions.—Maximum length, ·3 mm.

Age.—Barremian-Aptian ; U. Burma.

Mesania kutaungensis, sp. nov.

Test narrow, elongate, biserial ; sutures slightly incurved. This form possesses the

Mesania tibetica, sp. nov.

Test free, elongate, biserial, gradually tapering, with eight chambers in each row ; sutures incurved and tending to thicken at marginal junctions. The internal characters exhibited by this form appear to justify its reference to the genus *Mesania*, in spite of its rather tapering charatcer.

Dimensions.—The holotype measures ·4 mm. in length.

Age.—Aptian-Lower Cenomanian ; Tibet.

Genus *Kyatsokia*, nov.

Genotype *Kyatsokia tibetica*, sp. nov.

Generic Diagnosis.—Forms coiled, with chambers disposed more or less as in rotalids ; test calcareous ; number of whorls varying from one and a half to two and a half ; chambers increasing very gradually in size.

Description of Genotype.—Test calcareous, free, trochoid, rotaliform, consisting of one and a half whorls; sutures disposed obliquely to the axis of coiling, not deeply incurved; last whorl formed of six chambers.

Dimensions.—Maximum length, ·25 mm.

Age.—Aptian-Cenomanian; Tibet.

Kyatsokia multilocularis, sp. nov.

Test made up of two-and-a-half whorls, the last formed consisting of nine chambers. This is a more tightly coiled form than *K. tibetica*, just described; sutures slightly obliquely disposed. A fairly large-sized initial chamber appears to be present in the central portion of the test.

Dimensions.—Maximum length, ·2 mm.

Age.—Aptian-Cenomanian; Tibet.

The stratigraphic ranges assigned to the foregoing species are determined from those of the orbitolines with which the microforaminifera are associated.

The holotypes of all the species described above are preserved in the Geological Survey of India.

A detailed paper on these forms will be published in due course.

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2. Wilson, L. R. and Hoffmeister, W. S., *The Micropalæontologist*, 1952, **6**, No. 2, 26. Figs. 1-20.
3. Cloud, P. E. (Jr.), *J. Sed. Petr.*, 1948, **18**, No. 2, 56.
4. Dawson, J. A., *J. Exper. Zool.*, 1919, **29**, 498.
5. Kidder, G. W. and Stuart, G. A., *Physical. Zool.*, 1939, **12**, 329.
6. Kidder, G. W., Lilly, D. M. and Claff, C. L., *Biol. Bull.*, 1940, **78**, 9.
7. Lalicker, G. G., *J. Sed. Petr.*, 1948, **18**, No. 2, 51. Pl. 1, Fig. 1.
8. Moore, R. C., *Ibid.*, 1948, **18**, No. 3, 126.
9. Scott, H. W., *Ibid.*, 1948, **18**, No. 2, 65, Fig. 1.

OBITUARY

DR. M. A. GOVINDA RAU

THE death of Dr. M. A. Govinda Rau, Director, Alagappa Chettiar College of Technology, Madras, on November 19, has removed one of the pioneers in the field of chemical engineering in the country, and will be widely mourned by those who had the good fortune to know him.

M. A. Govinda Rau was born on 26th August at Viswammalsamudram in Trichinopoly District, and was the son of Rao Bahadur M. C. S. Ananthapadmanabha Rau who retired as Principal, Government College, Kumbakonam. After a brilliant academic career in the Presidency College under Prof. W. Erlam Smith, Govinda Rau joined the Indian Institute of Science as a research student. Later, he worked under Prof. Donnan of the University College, London, for his Ph.D. Degree. On his return from the United Kingdom, he joined the staff of the Indian Institute of Science and worked there first under Prof. H. E. Watson and later under Sir C. V. Raman.

In 1940, he organised the Department of Chemical Engineering which was started at the Institute, and was in charge of it for four years. When the Alagappa Chettiar College of Technology was started by the Madras University in 1944, he was first appointed as Reader in Chemical Engineering and later made Professor and Director. During the ten years of his stewardship he was responsible for building up the A. C. College of Technology to its present position. Though ailing for some time, he took an enthusiastic interest in the furtherance of the activities and technological development of the various sections of the College.

Dr. Govinda Rau was Vice-President of the Indian Institute of Chemical Engineers, Fellow of the Indian Academy of Sciences, President of the Faculty of Technology, Chairman, Board of Studies in Technology, and a member of various academic bodies. Nearly 60 original papers have been published by him relating to dielectric constants, dipole moments, ultrasonics, and various topics in chemical engineering. He was associated with *Current Science* from its very inception and was the Secretary of the Association for many years.

His contributions to physical chemistry, and the A. C. College which he helped to shape are perhaps the fittest memorial to his life and work.

K. N. MENON.

CORDIERITES FROM THE BURNT ROCKS OF THE JHARIA AND RANIGANJ COALFIELDS

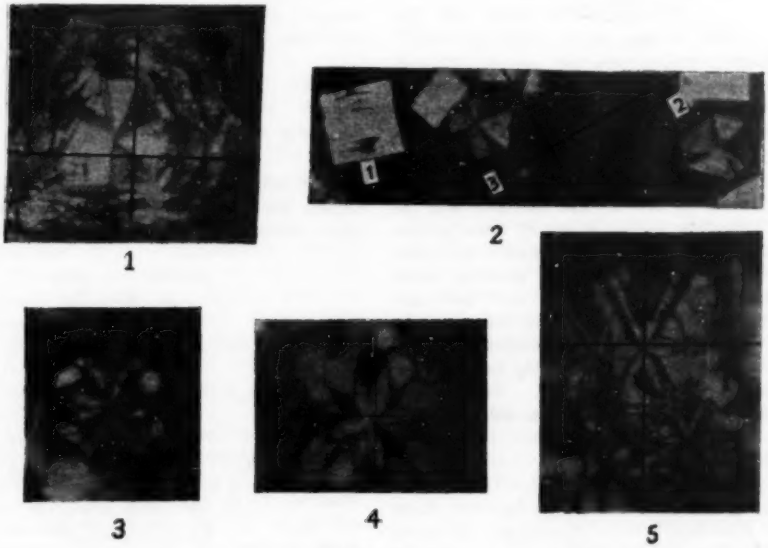
P. R. JAGAPATHY NAIDU

Dept. of Geology and Geophysics, University of Madras

VENKATESH[1] has described stellate twinning in cordierites from the Bokaro Coalfield. With the kind courtesy of Prof. N. L. Sharma and Dr. M. S. Sadasiviah of the Indian School of Mines, Dhanbad, cordierites from burnt rocks of the Jharia and Raniganj Coalfields were examined. The optic axial angles of cordierites, and the twin laws, vary from rock to rock. These are summarized below. The optical characters were determined on a Leitz Panphot microscope with a 4-axes stage, 1·557 segments and U.M. 4 objective. To save space, diagrams given by Rosenbusch-Mügge[3] for the various twin types, are referred to:

Type 1.—The grains found in vitrophyres and hornfelses of Laikdih seam, Ramnagar, Raniganj, are of the average size—prismatic 2 mm. to 1 mm. × ·4 mm. to ·3 mm., and basal, diameter ·2 mm. to ·4 mm. and show six sectors. The basal sections have pseudo-hexagonal crystal boundaries, and there are minute lamellæ parallel to these faces, but the sectors extinguish together, and the grains are either uniaxial or biaxial with a small optic axial angle (possibly below 20°), since, in one of the directions of the optical ellipsoid, the extinction is prolonged. The carbon inclusions are arranged as basal plates or plugs in the direction of the C-axis, and also along the concentric lamellæ. Sometimes, both basal and prismatic sections show complex patterns of extinction (Photo 1).

Type 2.—The grains found in the same rocks as above, are of the size-prismatic ·1 mm. to ·24 mm. × ·16 mm. to ·08 mm. and basal, diameter ·2 mm. to ·16 mm.,—and show six or twelve sectors. There are again lamellæ parallel to the bounding faces. In grains with six sectors, the bounding faces are (110), and they are twinned on the (130) law. The scheme of extinction is after Fig. 51-*b*, p. 375, Rosenbusch-Mügge,[3] such that two opposite sectors are extinguished, inclined to the plane of the polarizer (Grain 2, photo 2). In grains with twelve sectors, the bounding faces are (010), and the twinning is after the complex (110), (130). The scheme of extinction is after Fig. 50, p. 375, Rosenbusch-Mügge,[3] such that four sectors, forming a four-rayed figure, appear symmetrically extinguished on either side



PHOTOS 1–5

of the plane of the polarizer (Grain 3, photo 2). The result is that there are three diametrical planes indicating the composition faces (110), and three twin planes (130) perpendicular to these. The twin planes are not sharply located by a tilt on the Fedorow stage, whereas the composition faces give sharp intersections. The prismatic sections show carbon inclusions, arranged in plates parallel to the base, and show the Andreas cross (Fig. 1, and Grain 1, photo 2). The optic-axial angles range from

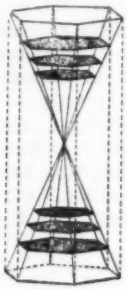


FIG. 1

$-2v = 23\text{-}46°$. The angles are variable in different sectors of the same grain.

Type 3.—The grains found in vitrophyres and hornfelses of the Vth seam, Jharia, are of the size-prismatic ·32 mm. to ·2 mm. × ·2 mm. to ·02 mm., and basal, diameter ·16 mm. to ·08 mm. The basal sections are always circular and do not show bounding faces. Many of these grains are corroded and the twinning lamellæ are partially destroyed. The prismatic sections show complexly intersecting lamellæ, and the carbon inclusions are arranged along these lamellæ. The twinning is of two major complex patterns. One of these is probably of the type photographed by Venkatesh.[1] This type (Fig. 2 and photo 3) is distinguished by a

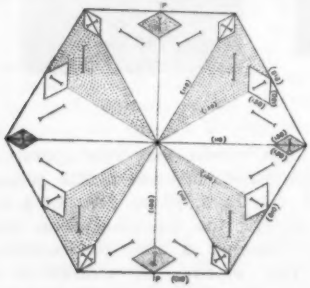


FIG. 2

central twelve-rayed star, twinned on the complex (110), (130), and the periphery is bounded by spots, more or less four-sided in outline, six of them large, and six small. The large spots have their obtuse apices pointing towards the centre, whereas the smaller ones have their acute apices so pointing. They consist of two hexlings, turned through 60° and interpenetrated. The spots are twinned on the (110) law, after the pattern, Fig. 49, p. 375, Rosenbusch-Mügge,[3] such that two of them opposite each other extinguish symmetrically, on either side of the plane of the polarizer. A modification of this pattern has all the twelve spots with their acute apices turned towards the centre (Fig. 3, photo 4). This type con-

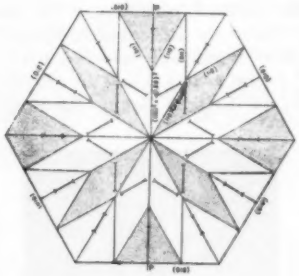


FIG. 3

sists of two hexlings twinned on the (110) law, turned through 30° and interpenetrated. The other complex pattern (Fig. 4 and photo 5)

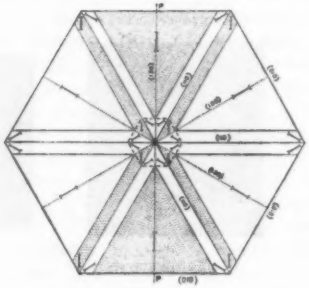


FIG. 4

has again a small twelve-rayed central core, twinned on the complex (110) (130), from which twelve lamellæ radiate to the periphery, twinned parallel to (110). The periphery is bounded by six sectors twinned on the (110) law. The optic axial angles measured on the sectors and spots of all these complex patterns range from $-2v = 69\text{-}72°$.

There was not much variation between the refractive indices measured on the grains of the above types. The range of refractive indices are $\alpha = 1{\cdot}530$-$1{\cdot}541$, $\beta = 1{\cdot}538$-$1{\cdot}543$, $\gamma = 1{\cdot}538$-$1{\cdot}544$. Cordierites of Type 3 (·3431 gm.) was partially analysed with the result, $SiO_2 = 55{\cdot}16$, $R_2O_3 = 42{\cdot}20$, $CaO = 0{\cdot}23$, $MgO = 1{\cdot}49$, $H_2O - = 0{\cdot}11$, $H_2O + = 0{\cdot}38$, Total = 99·57.

The evidence from these complex patterns seems to be that at high temperatures, the nucleus twins on the complex law, and, as the temperature falls, the periphery twins on the simple (110) law. Venkatesh[2] has made an extensive study of cordierites from India and has established this relation of the twin laws to temperature.

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WAVE MOTION AND VIBRATION THEORY*

THE addresses given at the fifth symposium in Applied Mathematics of the American Mathematical Society held at Carnegie Institute of Technology in 1952 have been published in book form and include some of the latest advances made in the field of wave motion and vibration theory. The first four symposia dealt with non-linear problems in mechanics of continua, electromagnetic theory, elasticity and fluid mechanics.

The first three papers by C. C. Lin, S. Chandrasekhar, P. R. Garabedian discuss stability of fluid motion. C. C. Lin gives an exhaustive treatment of plane flows. The exact solutions for Poiseuille and plane Couette flows show the absence of instability. For Couette flow G. I. Taylor's result is classical. For plane Poiseuille flow contradictory results have been obtained by different workers. Lin analyses them critically and shows that the critical Reynold's number is 5,300. This is confirmed by L. H. Thomas with the help of an automatic computation machine. He also discusses the complications arising in the limiting process.

Thermal instability in plane flow sets in when the Reynold's Number (R) exceeds the value 657·51, 1,100·6, 1,707·8, according as the bounding surfaces are both free, one rigid, or both rigid. Rotational instability sets in when the Taylor's number (T) exceeds the critical value 1,707·8. S. Chandrasekhar, who has done pioneering work in magneto-hydrodynamics, finds, by using a suitable variational principle, the critical values of R and T in the presence of a magnetic field. It is found that the Reynold's and Taylor's numbers do not agree for rigid boundaries as is the case in the absence of the magnetic field.

The third paper contains the work of P. R. Garabedian, H. Lewy and M. Schiffer on axisymmetric cavitational flows which arise out of modern projectiles moving rapidly through water. Variational methods are used to calculate the shape of the cavity.

The problem of a plane shock of finite strength in a non-viscous compressible flow striking symmetrically a wedge of finite angle is mathematically untractable. John von Neumann's local three shock theory has encountered a number of difficulties. W. Bleakney discusses these difficulties in explaining the Mach reflection at a finite angle.

N. W. Mclachlan discusses the solution of a non-linear differential equation which arises in connection with a hydroelectric power system. He employs the approximate method of slowly varying amplitude and phase and obtains a number of numerical results. S. Lefschetz has discussed a generalization of van der Pol's equation.

If λ is the square of the angular frequency of a given normal mode and v the potential energy. R. J. Duffin and A. Schild show that $\delta\lambda = \delta v$. This formula can be used to find the small increase in frequency due to a small increase of constraints. It is found that there can be cases in which a nodal line may exist in the gravest mode—a question first raised by A. Weinstein. R. J. Duffin and D. H. Shaffer have given two such examples. One is that of a clamped long rectangle overlapping a circle of suitable radius and the other of a concentric doubly connected region with a sufficiently small inner circle. In acoustics, if a wall separating two rooms has a small hole in it, one of the new frequencies is much lower than all the original frequencies,

* Wave Motion and Vibration Theory—*Proceedings of the Fifth Symposium in Applied Mathematics of the American Mathematical Society*—Vol. 5. (McGraw-Hill, 1954, Pp. v + 169—Price $ 7·00.)

J. J. Stoker makes out that the radiation or Sommerfeld condition is not sufficient for the unique solution of the radiation problem, as it precludes the possibility of incoming wave generated at infinity. He suggests that the unnatural steady state problem be approached as a limiting case of an initial value problem.

E. H. Lee discusses wave propagation in helical springs by taking the possibility of impact into consideration. A number of results deduced by him can be readily obtained if B. R. Seth's tension-stretch law, $T = \frac{1}{2} E[1 - (1+s)^{-2}]$, for finite deformation is used. It can be used both for extension and for contraction.

The remaining six papers deal with the solution of the wave equations under different boundary conditions with the help of Fourier or Wiener-Hopf integral representations. H. Levine improves on the method of L. V. King to calculate the radiation pressure on a plane circular rigid disc in the form of a single integral equation in place of a pair of dual integral equations. W. Magus shows that the determination of transmission coefficients for the diffraction of a plane scalar (acoustical) wave by a circular aperture in a plane infinite screen leads to infinite matrices. Albert E. Heins and H. Fersbach show that the incidence of a plane wave upon two semi-infinite half planes of different admittance joined along an infinite line gives rise to integral equations of the Wienor-Hopf type. G. F. Carrier and W. H. Munk develop the diffusion theory of tides into permeable rocks to explain the correspondence of the frequency of water level fluctuations in Hawaiian wells to those of the ocean tide. These results agree fairly well with the small observations available. A. Weinstein gives a complete solution of the Euler-Poisson-Darboux equation

$$\nabla^2 u^k = u_{tt}{}^k + kt^{-1}u_t{}^k,$$

where

$$\nabla^2 = \sum_{i=1}^{m} \partial^2/\partial x_i{}^2.$$

For $k=0$, it reduces to the ordinary wave equation. He uses the recursion identities

$$u_t{}^k(x,t) = t\, u^{k+2}(x,t),$$
$$u^k(x,t) = t^{1-k}\, u^{2-k}(x,t),$$

and a generalisation of Hadamard's method of descent. For the Darboux operator

$$L_a u = \Delta^2 u - u_{tt} - (a/t)ut,$$

these identities give

$$L_{\beta+2n} L_{a_n} L_{a_{n-1}} \ldots L_{a_2} L_{a_1} u^\beta = 0.$$

The general solution is made to depend on the formula

$$u^k = t^{1-k} \left(\frac{\partial}{t\partial t}\right)^n (t^{k+2n-1} u^{k+2n}),$$

where n is a positive integer such that

$$k + 2n \geq m - 1.$$

E. W. Montroll and J. M. Greenberg use the transform method to improve upon the earlier results on scattering of waves by soft obstacles.

The book can be warmly recommended to all mathematicians, physicists and engineers interested in vibration theory.

Indian Inst. of Technology, Kharagpur. B. R SETH.

RICE RESEARCH IN INDIA*

RICE, the most important food crop in India, occupies on an average 70 million acres. Research work on the crop has been going on for the past three decades and it is but fitting that the compilation of the voluminous, accumulated literature has been undertaken by the outstanding worker in the field, Shri K. Ramiah.

The monograph is divided into three parts. The very readable seven chapters under Part I are devoted to the general botany and taxonomy of the crop, its origin and antiquity and general breeding technique. Statistical figures on the acreage, production and yield of grain in different countries show that, while India has the largest acreage and second highest production, the yield per acre is low as compared to China, Japan, Formosa, Italy, Spain, etc. This problem of low yield in India has been discused in Chapter XX. In spite of three decades' work on the crop and the production of innumerable 'improved' strains at the various Research Stations (listed in *Appendix I*), only a fraction of the area seems to be under improved varieties.

The publication is a pointer to the fact that the low acre yields are not due to 'lack of experimental research or scientific knowledge'. To quote the authors, "the most significant reason appears to be the wide gap between research and extension". This is not only true for rice but for other crops as well. The present vigorous drive by the Central and State Governments for the propogation of the Japanese method of cultivation and carrying it to the

* *Rice Breeding and Genetics*. By K. Ramiah with the assistance of M. B. V. N. Rao (The Indian Council of Agricultural Research, Scientific Monograph No. 19), 1953. Pp. Illustrated vii+360. Price: Rs. 17 as. 8 or 27 *sh*.

doors of the cultivator through special staff appointed for the purpose, will, it is hoped, result in increased yields and lessening this gap between the research worker and the cultivator. The limitations in India for mechanised cultivation as adopted in many rice-growing countries is emphasised.

The collection and study of wild rices with a view to their utilisation in breeding has also been correctly emphasised. Similar collections in crops like wheat, potato and sugarcane have helped the breeder in his work of accumulation of wide and useful genetic stocks. The Central Rice Research Institute at Cuttack has recently launched a scheme for the collection of wild rices from the Jeypore tract.

The application of the breeding principles of introduction, selection and hybridisation has been dealt with in detail in Part II of the publication. The work done at the different research stations in India (before separation of Burma and Pakistan), numbering over thirty has been reviewed. The four chapters of this part call for little comment except that of recommendation to the worker in the line. It is clear that each State has its own problems in view of the varying soil and climatic conditions, and the way these problems are tried to be tackled makes informative reading.

The third part, *viz.*, genetics of rice, is essentially meant for the technical plant breeder. The two Chapters XIII and XIV dealing with the inheritance of characters are of importance in that they give an idea of the application of plant breeding and genetical methods to the production of varieties suited to varying needs. In this work the authors have their own share of contribution. The wealth of information available on this subject of mode of inheritance of morphological, physiological and quantitative characters, a knowledge of which is so essential for successful breeding, is brought out by the numerous references to the work of research workers. Detailed information on more than one hundred characters pertaining to those of stem, leaf, panicle, grain, etc., forms the subject-matter of the two chapters.

The need for the improvement of quality of rice, which is one of the practical problems connected with improvement of rice, is stressed in Chapter XIX. The external appearance of grain and its nutritive value do not seem to go hand in hand. Nutritively superior varieties are coloured and coarse and are not preferred by consumers. Attempts have to be made to evolve varieties satisfactory from the point of both external appearance and nutritive value.

Reference to nearly 500 publications is indicative of the wide coverage of the book and its monographic status.

With the wealth of information contained in the monograph, it looks like cavilling to point out a few minor defects. In view of the considerable time lag between the writing up of the main information and the printing of the monograph, the older terminology of 'Province' for 'State' persists. Plates I and II are not in their proper places. The other plates and figures could have been conveniently arranged on one side of the monograph which would have facilitated the reader. Besides the errata given at the end, there are still quite a few. The get-up of the book could have been better.

A short review of this kind cannot do full justice to the fund of information contained in the publication. There can be no doubt that this is a work which will be useful to specialists in the line as well as plant breeders, cytogeneticists and botanists in general.

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Coimbatore.

RADIATION GENETICS

ACCORDING to Dr. W. Ralph Singleton, Brookhaven National Laboratory in Upton, N.Y., radiation genetics—the development of new varieties of plants by the use of radiation—will soon become one of the most important events in the history of agriculture.

With the advent of atomic energy, many sources of radiation are more readily available and it has been possible to define accurately the way in which the radiations should be given, the biological conditions which must be fulfilled and the kind of radiations to use. Such studies have shown that the old concept that all radiation induced mutations are deleterious to the plant is not correct. Evidence on hand shows that some radiation induced mutations are desirable changes. New disease-resistant varieties of plants, and higher yielding types of plants have been produced in a short time and with limited expense. Success in these preliminary experiments seems to justify the use of radiation genetics on a much wider scale in plant and animal improvement.

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ON THE MASSES OF MESONS AND HYPERONS

In a previous publication[1] the author has proposed the following empirical rule for the masses of heavy particles:

$$M_n \simeq n\bar{M} \qquad (1)$$

where M_n = the rest mass of the particle designated by the integral quantum number n, $\bar{M} = m/2\alpha = \hbar/2ac$ = the mass quantum for heavy particles, where m = the electron mass, $\alpha = e^2/\hbar c$ = the fine structure constant, $a = e^2/mc^2$ = the classical electron radius. On the basis of the above rule, quantum numbers have been assigned to various particles. These quantum numbers are found to possess the statistical property by virtue of which the even quantum numbers refer to Bosons while the odd quantum numbers refer to Fermions.

Since more accurate measurements of some meson masses are now available, a fresh comparison of the calculated and the experimental masses is tabulated below with all masses expressed in the electron mass units:

Particle	Quantum number	Mass (calculated)	Mass (observed)
$\mu\pm$	3	206	207 ± 1^2
$\pi\pm$	4	274	273 ± 1^2
$\tau\pm$	14	959	966 ± 2^3

It is clear that the agreement between the calculated and the experimental masses is now much closer than before.

When the above rule was first proposed it was pointed out that it would be inconsistent to include the stable nucleon as a member of a set of such unstable particles as mesons and hyperons. Further the hyperon Λ^0 (formerly called V_1^0) was assigned the even quantum number $n = 32$ even though it is a Fermion by virtue of its decay scheme $\Lambda^0 \rightarrow P + \pi^-$. This situation is now aggravated by the discovery of the hyperon Y^- which has to be assigned the even quantum number $n = 38$ although it is a Fermion because of its decay scheme $Y^- \rightarrow \Lambda^0 + \pi^-$. Thus the statistical properties of the quantum numbers for the mesons and the hyperons appear to be opposite.

The above difficulties can be removed if one assumes that the nucleon is not a member of any such set and that the hyperons form a new set based on the nucleon just as the mesons form a set based upon the leptons. Thus one may propose a more general empirical rule as follows:

$$M_n = M_0 + n\bar{M} \qquad (2)$$

where M_0 = the mass of the basic particle. It is clear that for the mesons $M_0 \simeq 0$ and the new rule reduces to the previous rule, while for the hyperons $M_0 \simeq 1837$. A comparison of the calculated and the experimental masses for the hyperons is tabulated below with all masses expressed in the electron mass units:

Particle	Quantum number	Mass (calculated)	Mass (observed)
Λ^0	.. 5	2180	2181 ± 1^4
Y^-	.. 11	2591	2586 ± 12^5

It is clear that the above quantum numbers for the hyperons now possess the same statistical property as that possessed by the meson quantum numbers.

It will be interesting to observe whether further mass measurements would be consistent with the proposed empirical rule.

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Navarangpura, Ahmedabad-9,
August 5, 1954.

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DECAY OF PHOSPHORESCENCE OF LONG DURATION IN MAGNESIUM OXIDE

MAGNESIUM OXIDE when bombarded by cathode rays shows both fluorescence and phosphorescence. The fluorescence spectrum of a fresh specimen[1] shows two bands one of which is strong and broad having the peak at 4400-4550 Å (2·75 ev.) and the other is weak with peak at 5750 Å (2·16 ev.). The phosphorescence is mainly associated with the former band and

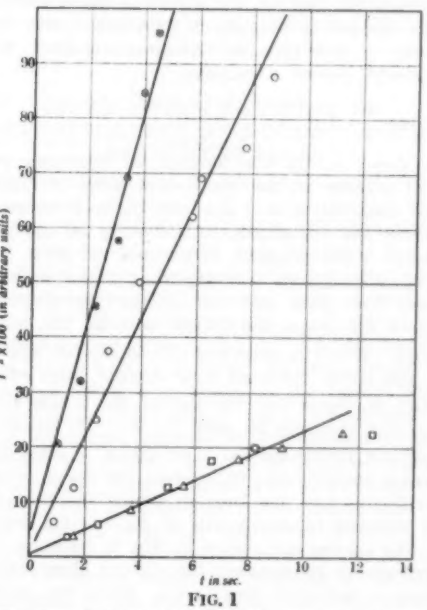

FIG. 1

⊗ Crystal Exposed to cathode rays for 20 hours
○ Fresh untreated crystal.
△ Crystal heated bunsen flame for 5 hours.
□ Crystal heated in oxygen coal gas flame for 3 min.

appears to be of long duration. We have studied the decay of phosphorescence in several samples, namely, (1) a fresh untreated specimen, (2) a sample having 20 hr. previous exchange to cathode rays, (3) a fresh sample heated in bunsen flame for 5 hr. and (4) a fresh sample heated in oxygen coal gas flame for 3 minutes. All the samples were clear cleavage pieces from a single crystal of MgO obtained from the National Research Council of Canada at Ottawa.

The arrangement for studying the decay of phosphorescence was as follows. The crystal was first excited to luminescence by turning on the cathode rays momentarily using the cathode

ray tube described previously.[2] The decay was then observed with the help of a Lummer Brodhun photometer and the time required for the phosphorescence to decay to fixed levels of intensity was determined, correct to 0·1 second. Each observation was repeated at least 20 times. The mean error in any single observation is about 10 per cent.

As is well known the phosphorescence of long duration may be ascribed to the re-combination of the trapped electrons with holes in luminescent centres, the electrons being excited into the conduction band thermally. For the decay of this type of luminescence, Mott and Gurney[3] derive a relation

$$I^{-\frac{1}{2}} = I_0^{-\frac{1}{2}} (1 + A\, n_0 t) \qquad (1)$$

where

$$I_0 = A\, n_0^2 \qquad (2)$$

In these, n_0 is the number of electrons per unit volume in the conduction band including the traps at time $t = 0$ and A is a constant giving the probability of radiating on capture, and I is the intensity of emitted radiation. For long after-glows the electrons come entirely from the traps and the sooner the electrons leave the traps the larger will be the value of A. If $I^{-\frac{1}{2}}$ in equation (1) is plotted against t, the curve obtained is a straight line, whose slope is $A^{\frac{1}{2}}$ and the intercept on the I-axis gives I_0 (the intensity at time $t = 0$). If, however, we plot $I_0^{\frac{1}{2}}/I^{\frac{1}{2}}$ against t we get a straight line whose slope is An_0. This gives the decay period $t = 1/An_0$, i.e., the time in which the intensity is reduced to one-fourth of its original value.

The curves are shown in Fig. 1. Relation (1) appears to be satisfied though the observations have a restricted time range. From the curves the values of $I_0^{-\frac{1}{2}}, A^{\frac{1}{2}}$, n_0 and An are obtained as given in Table I.

TABLE I

Specimen	$I_0^{-\frac{1}{2}}$†	$A^{\frac{1}{2}}$	n_0‡	An_0
20 hr. previous exposure to cathode rays	$\frac{1}{20}$	$\frac{1}{5}$	100	4
*Fresh untreated specimen	$\frac{1}{40}$	$\frac{1}{10}$	400	4
Heated specimens	$\frac{1}{200}$	$\frac{1}{50}$	10,000	4

* The scatter of points about the line is rather large in this case, and therefore the figures given may be slightly in error; † The value of I_0 has been obtained by extrapolation, and is in arbitrary units; ‡ The valves have only relative significance.

It is interesting to note that the decay curves for different specimens show widely divergent slopes. But the decay period is almost the same for all of them and of the order of 0·25 second. We see further that the number of electrons in the conduction band is relatively smaller for the specimen having large previous exposure to cathode rays, than for heated specimens. This may also be inferred directly. In the former case the phosphorescence becomes too feeble to be perceived by the eye in five seconds, though it continues for 17 seconds in heated specimens. Since the decay period is the same for both it follows that the former must have a smaller value of I_0 and therefore of n_0.

The theory supposes that every electron in the conduction band gives rise to luminescence. It is, however, possible that the impurity centre is such that there are both populated and vacant levels in the region between the conduction and the valence band of the crystal and the vacant levels lie between the conduction band and the populated levels. Cathode ray excitation creates holes in the populated levels and in the valence band, but some of the electrons from the conduction band will be captured by the vacant levels and will be unable to produce luminescence by combining with holes in the populated levels. Thus the effective number of electrons producing luminescence can be much smaller than the actual number. It is possible that the impurity centres created by cathode ray excitation (these are possibly metal-ion-excess centres) have such levels. Weber[4] finds that MgO heated in Mg vapour has absorption bands at 2·35, 3·6 and 4·93 electron volts and photoconductivity experiments of Day[5] show that the 3·6 ev. levels are empty and their number is much larger than that of the populated 2·35 ev. levels. The large value of n_0 in heated specimens may be due to the presence of some populated impurity level very close to the conduction band.

One of us (L. M. P.) has to thank the Council of Scientific and Industrial Research for a scholarship.

University of Allahabad, B. D. SAKSENA.
Allahabad, *August* 24, 1954. L. M. PANT.

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THE NUCLEAR POTENTIAL WELL FOR HIGH ENERGY NUCLEON SCATTERING

To correlate the experimental data on the nuclear scattering of 90 Mev. neutrons, Fernbach, Serber and Taylor[1] have introduced the optical model of the nucleus. In this model a nucleus is represented by a sphere with a uniform distribution of nuclear matter characterised by a complex refractive index for the nucleon wave given by

$$n = 1 + k_1/k + i(K/2k) \qquad (1)$$

The real parameter k_1 is obtained by assuming a real potential well from the expression

$$(k_1/k) = [\{(E+V)^2 - \mu^2c^4\}/\{E^2 - \mu^2c^4\}]^{\frac{1}{2}} - 1 \qquad (2)$$

where V = the depth of the potential well while the other parameters have their usual meanings.

However, there is also another expression[2] for this parameter given by

$$(k_1/k) = (\pi\rho/k^2)\{f_{nn}(0) + f_{np}(0)\} \qquad (3)$$

where $f_{nn}(0)$ and $f_{np}(0)$ are the forward scattering amplitudes for (n, n) and (n, p) scattering respectively, and ρ is the nucleon density. Since the nucleon-nucleon scattering experiments do not provide these forward scattering amplitudes unambiguously one obtains them by assuming some models for the nucleon-nucleon interaction. We have obtained from Jastrow[3] the plots of k_1 against energy for the tensor interaction model of Christian and Hart[4] and Christian and Noyes[5] as well as for the hard core nucleon model of Jastrow[6] for the nuclear radius given by $R = 1{\cdot}38 \times 10^{-13} \times A^{\frac{1}{3}}$ cm.

We have obtained the depth of the potential well by equating graphically the parameter k_1 for an energy E obtained from equation (2) with the parameter k_1 at (E + V) Mev. obtained from equation (3) for the above models for the nucleon-nucleon interaction. We find that the potential decreases practically linearly from V = 29 Mev. to V = 22 Mev. for the tensor interaction models and from V = 17 Mev. to V = 10 Mev. for the hard core model respectively when the energy varies from E = 90 Mev. to E = 320 Mev.

Fernbach, Serber and Taylor[1] had assumed V = 30 Mev. to explain the experimental data on the nuclear scattering of 90 Mev. neutrons. It can be seen that the tensor interaction models give V = 29 Mev. while the hard core models give V = 17 Mev. Thus the previously assumed potential well agrees with the potential given by the former model in the case of a uniform nuclear density distribution.

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ON AN ABNORMAL TYPE OF TRYBLIOLEPIDINE-NUCLEOCONCH FROM AUSTRALIA

Various horizons of *Lepidocyclina*-bearing beds have been reported from the Australian Tertiaries. Of these the subgenus *Trybliolepidina* has been reported only from Victoria, and is restricted to the Tertiary-'*f*' stage in the Indo-Pacific region. These have been studied in detail by Miss Irene Crespin.[1] Recently the present author along with Sah, D. L., Mohan, K. and Rao, V. V.,[2] reported the occurrence of *Trybliolepidina* from India, in the Lower Miocene (Upper Burdigalian) beds of Kathiawar.* The Australian species of *Trybliolepidina* described by Crespin are: *Lepidocyclina* (*Trybliolepidina*) *batesfordensis*, *L.* (*T.*) *howchini*, and *L.* (*T.*) *gippslandica*. The Indian species are different from the Australian species.

The material for the present study was kindly lent by Miss Crespin and consists of several specimens of the two species: *L.* (*T.*) *batesfordensis* and *L.* (*T.*) *howchini*. Several oriented sections were prepared of these specimens, and only one section of *L.* (*T.*) *batesfordensis* shows the abnormal type of nucleoconch described below.

The nucleoconch of a typical *Trybliolepidina* consist of two chambers, the smaller one called the protoconch which is surrounded on three sides by the larger chamber called the deuteroconch. The nucleoconch generally has a thick wall and is surrounded by six to eight nepionic chambers. The equatorial chambers are ogival to spatulate in shape.

In the present specimen, the nucleoconch, instead of having two normal chambers, consists of three chambers. Here the normal proto-

* Previously, this was recorded as Vindobonian. This is now being considered as Upper Burdigalian in view of the recent work done in this Department.

conch has been replaced by two chambers, which are partially surrounded by a third one, which is the normal deuteroconch. These three chambers are enclosed within a thick wall and are then surrounded by eight nepionic chambers, two principal auxiliary and six ad-auxiliary chambers.

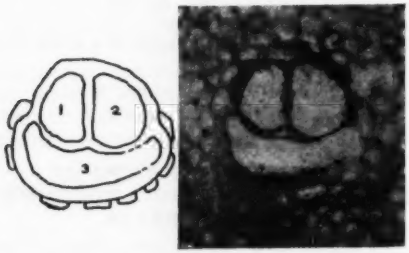

FIG. 1. *Lepidocyclina* (*Trybliolepidina*) *batesfordensis* showing abnormal type of nucleoconch, × 45.

It is quite obvious that some type of protoconchal division has taken place here giving rise to this abnormal type of nucleoconch. Crespin (personal communication) did not notice such a striking case of abnormality in this species.

Measurements of the nucleoconch

Diameter of the first chamber	..	124·7 μ
do. second chamber	..	154·8 μ
do. third chamber	..	417·1 μ
Width of the first chamber	..	189·2 μ
do. second chamber	..	202·1 μ
do. third chamber	..	116·1 μ
Thickness of the partition-wall between chambers 1 and 2	..	21·5 μ
Thickness of the partition-wall between chambers 1 and 3	..	17·2 μ
Thickness of the partition-wall between chambers 2 and 3	..	17·2 μ
Thickness of the outer-wall	..	38·7 μ

The equatorial layer is polygonal with seven rays extending almost to the margin of the test. The equatorial chambers are ogival near the nucleoconch but becomes spatulate near the periphery. In the rayed portion the chambers are spatulate to hexagonal in shape.

Cushman[3] has also noted some forms of abnormalities in Orbitoididæ. He stated: "Abnormality of the initial chambers is of rather common occurrence in some genera of the Orbitoididæ. It is the multiplication of the initial chambers which produces the phenomenon designated 'gigantisme' by H. Douville".

The author is grateful to Miss Irene Crespin, not only for the loan of the above material, but also for the valued opinion and kind permission to publish this note. Grateful thanks are also due to Prof. S. R. Narayana Rao for guidance and encouragement.

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PYROPHOSPHATE COMPLEXES OF NICKEL AND COBALT

IN a previous communication the work on pyrophosphate complexes of tin and zinc was briefly reported.[1] The present investigation deals with a study of similar complex formation with nickel and cobalt at room temperature by potentiometric, conductometric and spectrophotometric methods. The effect of dilution has also been studied, the dilution range being 1 to 50, for potentiometric and conductometric, and 1 to 10 for spectrophotometric studies. The Marconi glass electrode was used for potentiometric, the Kohlrausch bridge for the conductometric and Coleman Model 14 universal instrument (visible region) with 4 cm. cell for spectrophotometric studies.

From the pH conductivity curves the ratio of P_2O_7: metal in the complex has been found to be 1 : 1 as well as 2 : 1 for both the metals, i.e., $[Ni(P_2O_7)]^{-2}$, $[Ni(P_2O_7)_2]^{-6}$ and $[Co(P_2O_7)]^{-2}$, $[Co(P_2O_7)_2]^{-6}$ (complex). Haldar[2] has similarly reported the existence of these complexes in both the ratios, whereas Rogers and Reynolds[3] mention only 1 : 1 ratio.

Job's[4] method of continued variation was employed for spectrophotometric measurements and the complex was found to correspond to 1 : 1 ratio. The maximum absorption regions for nickel and cobalt complexes were found at 550 and 425 mμ respectively. The instability constant K of both these complexes has been calculated according to the method of Harvey[5] and found to be of the order of 10^{-4} for both the metals. James and Arnold[6] also have reported a value of the same order for the copper pyrophosphate complex (1 : 1) by the spectrophotometric method.

The behaviour of these complexes in electroplating baths is being investigated.

Our thanks are due to Prof. K. R. Krishnaswami for his keen interest in the investigation. One of the authors (J. V.) is grateful to

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THE CALCULATED THERMODYNAMIC PROPERTIES OF CARBONYL FLUORIDE

THERMODYNAMIC properties of formaldehyde, deuteroformaldehyde, phosgene, and thiophosgene are calculated by Thompson (1941[1]). In the present report the thermodynamic quantities (heat content, free energy, entropy and heat capacity) are calculated for carbonyl fluoride, which also belongs to the above series of compounds. These thermodynamic quantities are calculated for temperatures from 100° K to 1000° K to a rigid rotator harmonic oscillator approximation for the ideal gaseous state at 1 atmos. pressure. The frequencies of the fundamentals are (Nielsen *et al.*[3]).

$\nu_1 = 965$ cm.$^{-1}$, $\nu_2 = 1928$ cm.$^{-1}$, $\nu_3 = 626$ cm.$^{-1}$,
$\nu_4 = 1248$ cm.$^{-1}$, $\nu_5 = 584$ cm.$^{-1}$, $\nu_6 = 774$ cm.$^{-1}$

The moments of inertia are (Nielsen[2])

$I_A = 69{\cdot}98 \times 10^{-40}$ gm. cm^2, $I_B = 71{\cdot}70 \times 10^{-40}$ gm. cm^2
$I_C = 141{\cdot}68 \times 10^{-40}$ gm.cm^2

The calculations are summarised in the following table.

TABLE I

Heat content, free energy, entropy and heat capacity of carbonyl fluoride in gaseous state at 1 atm. (calories per mole/° C.)

T(°K)	$(H^\circ - E_0^\circ)/T$	$-(F^\circ - E_0^\circ)/T$	S°	C_p°
100	7·95	43·95	51·91	8·00
200	8·23	49·50	57·73	9·29
300	8·92	52·98	61·91	11·32
400	9·75	55·66	65·41	13·08
500	10·56	57·92	68·48	14·45
600	11·30	59·90	71·20	15·50
700	11·96	61·70	73·66	16·30
800	12·54	63·36	75·90	16·92
900	13·05	64·83	77·89	17·40
1000	13·51	66·25	79·76	17·78

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CRYSTALLINE COMPONENTS OF THE ROOTS OF *TEPHROSIA MAXIMA* AERS.

FROM the roots of *Tephrosia maxima* Aers. which grows abundantly in Waltair we have isolated 3 crystalline substances (I, II and III) in yields of 0·8, 1·0 and 0·8 per cent. respectively. Their salient properties are given below:

I: m.p. 227-29°, probable formula $C_{17}H_{10}O_6$, free from methoxyl; II: m.p. 126-28°, probable formula $C_{22}H_{20}O_5$ or $C_{17}H_{14}O_4$, free from methoxyl; III: m.p. 143-45°, probable formula $C_{23}H_{22}O_6$ with one methoxyl group. All the 3 substances gave a positive reaction for the presence of the methylenedioxy group as tested by the gallic-sulphuric acid reaction.[1] None of them gave a ferric colour and all of them were recovered after heating with acetic anhydride and sodium acetate at 140° for 3 hours. On hydrolysis with 12 per cent. aqueous alcoholic KOH, all of them yielded formic acid (identified by its reducing action on mercuric chloride and by its reduction to formaldehyde which again was identified by its colour reactions) and phenolic ketones indicating that they may be isoflavones. Among the products of KOH-H_2O_2 treatment, piperonylic acid was identified in the case of I and II.

A consideration of the properties (including toxicity to fish, not recorded here) and reactions of these compounds indicates that they may not be identical with any of the substances described earlier in the literature. They are therefore tentatively designated Maxima Substance A, Maxima Substance B and Maxima Substance C respectively. Full details will be published elsewhere.

We thank Sri. C. Rajasekhara Mudaliar, Agricultural College and Research Institute, Coimbatore, for the identification of the plant.

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EXCRETION OF NICOTINURIC ACID AS A METABOLITE OF NICOTINIC ACID BY RICE MOTH LARVA

In an earlier communication from this laboratory,[1] it was reported that the rice moth larva (*Corcyra cephalonica* St.) excretes exogenously supplied nicotinic acid or nicotinamide mainly as nicotinic acid and that N'-methyl nicotinamide is not the principal end product of niacin metabolism in this insect larva, unlike in many species of higher animals. We have since observed that the larva excretes, besides nicotinic acid, nicotinuric acid, which is the glycine conjugate of nicotinic acid, in smaller but significant amounts.

The excreta of rice moth larvæ maintained on an experimental diet[1] containing nicotinic acid or nicotinamide at a level of 4 mg. per 10 g. of diet were extracted with water, the extract concentrated *in vacuo* and finally taken up in 50-60 per cent. alcohol. 100 mg. of the excreta was thus worked up to yield about 0·5 ml. of the final concentrate. The concentrated extract was analysed chromatographically for niacin metabolites as described previously.[1] Nicotinuric acid was identified in the fæcal extract against an authentic sample chromatographed alongside the extract in the usual way. Further confirmation in this regard was obtained as follows:

The concentrate obtained from 200 mg. of larval excreta was placed as a series of spots on two big sheets (40 × 28 cm. each) of Whatman No. 1 filter-paper and resolved by irrigating the papers with the upper phase of a mixture of *n*-BuOH : MeOH ; Benzene : Water (2 : 1 : 1 : 1). Reference strips were cut out from the dried sheets and developed with cyanogen bromide and benzidine.[1] By reference to these strips, the portions of the two original chromatogram sheets expected to carry the metabolite suspected to be nicotinuric acid were cut out and eluted with successive portions of distilled water. The combined eluate, after concentration *in vacuo*, was hydrolysed with 5 N hydrochloric acid in a sealed tube at 100° C. for 3 hours. After removal of most of the hydrochloric acid, the hydrolysate was concentrated and finally adjusted to pH 7·0 and chromatographed as usual. A concentrate of the eluate from the chromatogram prior to hydrolysis was also run alongside. Two solvent systems, namely, *n*-BuOH : MeOH : Benzene : Water (2 : 1 : 1 : 1) and *n*-propanol : Water (60 : 40) were used. The unhydrolysed concentrate yielded the nicotinuric acid spot, but the hydrolysate showed up no spot due to this metabolite, but exhibited spots corresponding to pure nicotinic acid and glycine. The R_f values of the various substances are listed in Table I.

TABLE I

R_f values of the various metabolites

Metabolite	Reaction and colour	R_f value in A	R_f value in B
Nicotinic acid ..	CNBr and Benzidine Pink spot	0·80	0·47
Nicotinamide ..	CNBr and Benzidine Brownish pink spot	0·89	0·77
Nicotinuric acid	CNBr and Benzidine Light violet spot	0·74	0·34
Glycine ..	Ninhydrin–Violet spot	0·50	*

A – Propanol : water, B—BuOH : MeOH : Benzene : H_2O.

* The hydrolysate of the chromatogram eluate gave a streak.

An interesting observation was the presence of nicotinuric acid in the larval excreta even when nicotinamide was ingested. This points further to a deamidating mechanism being present in the larvæ, since conjugation of nicotinamide with glycine to form nicotinuric acid has to be preceded by the conversion of nicotinamide to nicotinic acid.

Controversial reports have appeared in the literature in regard to the role of nicotinuric acid as a normal end product of niacin metabolism in mammals.[2-6] However, the latest evidence[7] based on experiments with C^{14}-labelled nicotinic acid and nicotinamide indicates that nicotinuric acid is to be considered rather as a detoxication product of nicotinic acid formed extensively when massive, as distinct from physiological, doses of the vitamin are administered. The work of Johnson and Lin[7] as well as that of Kodicek and Reddi[8] further demonstrates that little nicotinuric acid is excreted by the rat when it is given a supplement of nicotinamide. This is in contrast to our findings, as the rice moth larva excretes the glycine conjugate even when fed nicotinamide. This fact, in conjunction with our earlier observations,[1] would indicate that the larva metabolises the vitamin somewhat differently from the rat.

Recently evidence has been accumulating[9-11] to show that CoA is involved in the enzymatic synthesis of hippuric acid from glycine and benzoic acid, and, as suggested by Chantrenne,[9] CoA might also participate in other condensation reactions involving a carboxyl group. The very recent work of Schachter and Taggart[12] on glycine-N-acylase is in conformity with such a hypothesis. In this connection the demonstra-

tion by Jones and Elliott[13] of the synthesis of nicotinuric acid *in vitro* from glycine and nicotinic acid is of interest. An investigation of the possible role of pantothenic acid in the formation of nicotinuric acid, which appears to be analogous to the biosynthesis of hippuric acid,[14] is in progress in the rice moth larva as well as in the rat and will be published in detail elsewhere.

We wish to thank Dr. E. Kodicek for the generous gift of nicotinuric acid and the Lady Tata Memorial Trust, Bombay, for the award of a research scholarship to one of us (T. K. S.).

Univ. Biochem. Lab., Madras-25, *September* 24, 1954.

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SURFACE DEPENDENCE OF NON-SELF-MAINTAINED REGION OF A.C. ELECTRIC DISCHARGE IN IODINE VAPOUR

IN a previous communication,[1] it has been pointed out that over a narrow potential region corresponding to the non-self-maintained region of an a.c. electric discharge in iodine vapour, even visible light initiated the discharge; this is accompanied by the production, on otherwise smooth sinusoidal current trace, of pulses of uniform height as in the well known Geiger region of G.M. counters operated by unidirectional potentials.[2] Further, the width of the non-self-maintained region decreased markedly by continued working of the system at potentials above the threshold of the self-maintained discharge.[1] It is well known that essentially the same behaviour is noticeable in the counters, which has been attributed to the decomposition under electron impact of the polyatomic molecules like alcohol vapours, etc. In view of the absence of any such circumstance in systems containing iodine, the above appeared to be of interest. The data reported below indicate, for the first time, the marked dependence of the non-self-maintained region on the electrode surface, to be distinguished from the homogeneous gas phase.

The experimental arrangement was essentially the same as described earlier.[1] Cylindrical discharge tubes made out of soft soda glass and filled with iodine vapour were employed. They were fitted with external sleeve electrodes and excited by 50 cycle potentials; the current was investigated by a cathode-ray oscillograph and a galvanometer.[1] Fig. 1 gives a

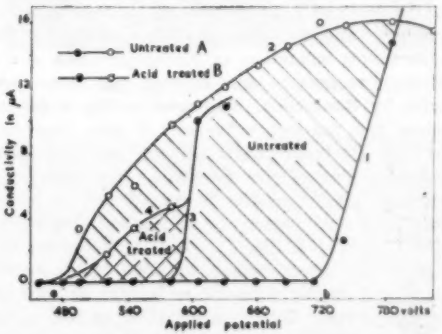

FIG. 1. Non self-maintained region of a.c. electric discharge in iodine vapour in acid-treated and untreated discharge tubes (Curves 1 and 3—in dark, 2 and 4—under light from 200 watt bulb).

typical series of results in two discharge tubes *A* and *B*; the walls of the vessel *B* were treated with chromic acid and boiling distilled water to remove surface alkali,[3] before admitting iodine vapour therein. The system *A* was not treated likewise. It was interesting to note that in the potential range *ab* (Fig. 1), the discharge in the absence of external radiation was negligible as evidenced by the very small conductivity *i* (Curve 1, Fig. 1), and non-occurrence of pulses on the oscillographic screen (Fig. 2, *a*). When the system was exposed to visible light (7800-3700 Å), a marked

increase of i, accompanied by the production of pulses on the current trace (Fig. 2 *b*), was

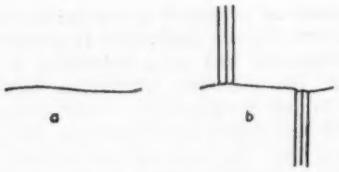

FIG. 2. Oscillograms representing the current structure in non-self-maintained a.c. electric discharge (*a*—in dark, *b*—under light from 200 watt bulb).

noticed; these features were observed so long as the external radiation was on. Above the potential *b* (Fig. 1), the discharge became self-maintained.[1] It may be noted from curves (1) and (2) of Fig. 1 that at large V (> 780 volts), the effect of irradiation is to decrease the conductivity i. When the radiation was cut off, the initial value of i was restored immediately (Curve 1, Fig. 1). This decrease of i with external light, which is reproducible beyond doubt of experimental error, cannot be anticipated from general theoretical considerations of photo- and thermo-electric effects.[7] The differential behaviour of discharge tubes *A* and *B* with respect to this finding, has been dealt with by Ramaiah.[8] The data in Fig. 1 further show the marked influence of acid treatment of the electrode walls on the non-self-maintained region of the discharge; the removal of surface alkali which decreased the potential width of this region, is of marked importance (*cf.* Curves 1-4, Fig. 1). It is well known that ordinarily, glass surface contains water vapour adsorbed in the form of molecular or van der Waal's layers. During evacuation of the system prior to introduction of iodine, they are in part removed.[3] Existence of compounds like alkali on glass surface inhibits their removal; this is in accord with the experiments of Faraday,[4] Warburg and Imhori,[5] and Harries and Schumacher[6] on the adsorption of water vapour on glass surface with and without alkali. This is substantiated by the observation that the removal of water vapour from glass walls by process of degassing the vessel at 200° C., also reduced the non-self-maintained region in iodine vapour. Thus, water vapour layers adsorbed on the electrode walls appeared to influence markedly the potential width of the non-self-maintained region in iodine vapour. This is in good agreement with the data obtained with various films like KCl, NaOH, KI, etc., deposited on the walls of B, which affect appreciably the content of an der Waal's adsorption of water vapour, and therefore, the potential width of the non-self-maintained region in iodine vapour.

The details of the results and the mechanism responsible therefor, will be published elsewhere.

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DOUBLE ENTERIC INFECTION BY *SALMONELLA TYPHI* AND *SALMONELLA PARATYPHI* A.

Two main types of Salmonella infection in man may be distinguished. These are: (*a*) the slow, continued fevers of the "enteric type", *viz.*, the typhoid-*para*-typhoid fevers, and (*b*) the sudden, usually transient, stormy, gastro-intestinal disturbances of the "food poisoning" types. Of these, the "enteric group" of fevers are due to the common infections and typhoid fever has remained one of the most widespread and important of all bacterial diseases, wheras the less common *para*-typhoid infections are milder but are otherwise similar to infection with the typhoid bacillus. The only method by which typhoid and *para*-typhoid fever can be distinguished with certainty is by the isolation and identification of the causal micro-organisms.

Kayser[1] was among the first to describe a case of enteric fever in which two organisms of the enteric group (*Sal. typhi* and *Sal. paratyphi* A.) were isolated during the course of the disease. Leboeuf and Braun[2] found only one case in a series of 12,028 blood cultures. A case of *triple* enteric infection has been described by Castellani[3] in 1915. There are records of *thirty-nine* isolated cases so far in which the diagnosis of double enteric infection can be accepted (Battyshaw and Mackay[4]). (A double enteric infection is defined as the

simultaneous infection of an individual or a group of individuals, with two organisms of the enteric group).

In reviewing the literature, double enteric infection has not been reported so far in India. A case of double enteric infection is reported where the diagnosis was established bacteriologically by isolating *Sal. typhi* and *Sal. paratyphi* A., from the blood of a patient. This is considered to be of importance in the clinical, bacteriological and epidermiological studies of enteric infections.

A detailed report is under publication elsewhere.

The authors' thanks are due to Col. B. L. Taneja, for his keen interest in this investigation.

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ON BLACK-GRUB DISEASE IN THE FRESH-WATER CARP *CATLA CATLA*

IN September 1953 a high mortality was reported among the fingerlings of the fresh-water carp *Catla catla* kept in one of the State fisheries pond at Samalkot (E. Godavari Dt.). About 100 of the fingerlings of various sizes were sent to us for examination. It was observed that many of the fingerlings showed black ovoid or irregular patches on the body surface which on closer examination proved to be the black pigment patches overlying metacercaria cysts of the digenetic trematode,

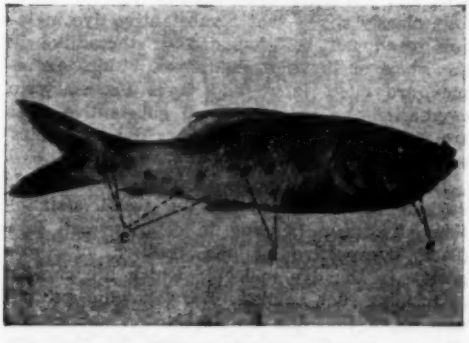

FIG. 1. Fish infected with Metacercariæ cysts (*c*).

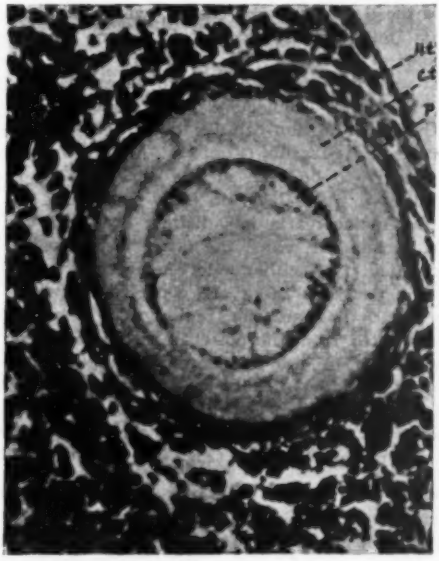

FIG. 2 Section of muscle with cyst. *c.t.*, connective tissue layer ; *H.t.*, Host tissue ; *P.*, Parasite.

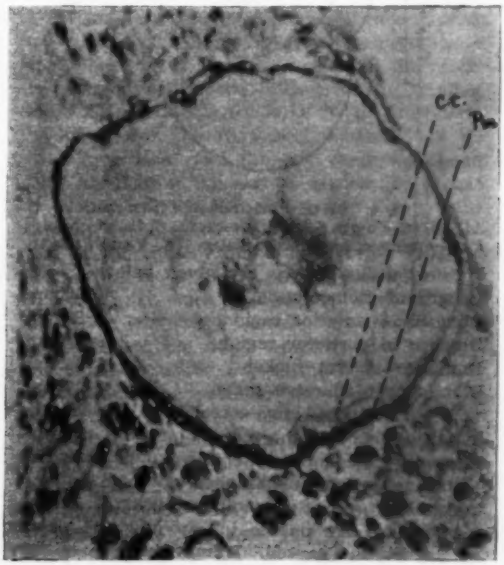

FIG. 3. Section of cyst showing pigmented zone (*Pm*)

Diplostomum sp. (Fig. 1). The cysts are located in the muscles just beneath the skin with a tendency to crowd at the bases of the major fins like the dorsal and the caudal, where adjoining cysts might even fuse and assume varying shapes. Normally, the cysts are oval. The cyst-wall is composed of two layers, a thick outer cellular connective tissue layer overlies a thin hyaline non-cellular layer which closely invests the parasite (Fig. 2). A pigment zone is clearly to be seen at the periphery of the connective tissue layer in most cysts (Fig. 3).

The metacercaria has distinct oral and ventral suckers, of which the latter is transversely elongated. On either side of the anterior end of the parasites there are conspicuous pseudosuckers. The anterior region of the body is demarcated from the posterior region by a constriction. In the anterior cup-shaped region are situated the suckers as well as an adhesive organ behind the ventral sucker. The rudiments of the reproductive system are situated in the posterior region (Fig. 4). Measurements

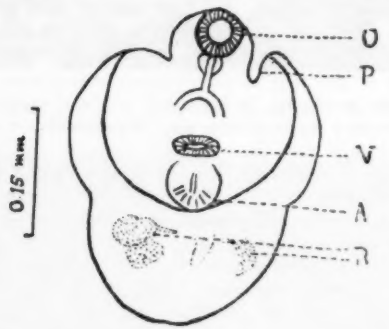

FIG. 4. Metacercaria removed from cyst.
A, Adhesive organ; *O*, Oral sucker; *P*, Pseudosucker; *R*, Rudiments of reproductive system; *V*, Ventral sucker.

of the various regions are given below.

Length of metacercaria	..	0·38 mm.
Breadth of anterior region	..	0·32 mm.
Breadth of posterior region	..	0·23 mm.
Diameter of oral sucker	..	0·05 mm.
Diameter of adhesive organ	..	0·07 mm.

We did not find any correlation between the length of fish and the number of cysts present. Mortality rate among the infected fish appears to be high as fish under observation in aquaria tanks died one after another quickly. At the moment we are unable to say how the death of the host is caused. It may be due to the movements of the parasite within the tissues of the host as reported by Davis[2] for other strigeid metacercaria or it may be the result of the toxins liberated by the parasites. This aspect is under investigation. Not only fish but also amphibians[2] and even snails[1] are reported to harbour the metacercaria of *Diplostomum flexicaudum*.

Patwardhan[5] and Lal[4] described the adults of a strigeid trematode *Proalaria alcedensis* from the intestine of the Kingfisher *Alcedo atthis*. The genus *Proalaria* has now been shown by Dawes[3] as a synonym of *Diplostomum*.

This is the first record of the larvæ of the genus *Diplostomum* from India. Further observations and experiments are in progress with a view to elucidate the life-cycle of the parasite and histo-pathology of the host's tissue.

Dept. of Zoology, P. N. GANAPATI.
Andhra University, K. HANUMANTHA RAO.
Waltair, *July* 19, 1954.

1. Cort, W. W. and Brackett, S., *J. Parasitol.*, 1937, **23** (5), 545.
2. Davis, J. D., *Ibid.*, 1936, **22** (4), 329.
3. Dawes, B., *The Trematoda*, 1946, Camb. Univ. Press, 373.
4. Lal, M. B., *Proc. Ind. Acad. Sci.*, 1939, **10**, 178.
5. Patwardhan, S. S., *Ibid.*, 1935, **2**, 22.

DIRECT COTTON DYES

IN a paper on atomic models in relation to some stereochemical problems in dyeing[1] Conmar Robinson has stated that Chlorantine Fast Green BLL has been cited by me as an example of a dye "which is far from linear". The passage under reference[2] reads in fact as follows: "However, an inspection of the scale drawing (Fig. 8) of Chlorantine Fast Green BLL, a dye which is derived from cyanuric acid and has excellent substantivity for cellulose, clearly shows that a substantive dye molecule need not be elongated or threadlike in the sense of the benzidine dyes. More examples are cited later, and it is necessary to emphasize the point that all substantive dyes are not 'long, linear, and planar dye molecules' as stated so frequently."

Robinson has also stated that "the models suggest that, contrary to the usual assumptions, hydrogen bonding to cellulose can take place irrespective of the position of those groups in the dye molecule which are capable of forming such bonds". The following extract[2] will show that the assumption is not usual: "the hydrogen-bonding groups in the dye molecule may be spaced at about 10-11 A to

conform to the repeating units in cellulose; but as seen from the drawings of the five dye molecules in Fig. 7, considerable flexibility in this regard is permissible because of the large number of hydroxyl groups in cellulose".

Dept. of Chem. Tech., K. VENKATARAMAN.
Bombay 19, *October* 15, 1954.

1. *Discussions of the Faraday Society*, 1954, No. 16, 123.
2. *The Chemistry of Synthetic Dyes*, Vol. 2, p. 2, 1283, Academic Press, New York, 1952.

'MODERATOR BAND' IN THE HEART OF *COLUMBA LIVIA*

WHILE studying the heart of *Columba livia* for detailed study of its anatomy and histology, a distinct band of muscle fibres present on the left side of septum ventriculorum was noticed. Subsequent study of the structure revealed that such a compact band of cardiac fibres has also been noticed by previous workers who attributed much physiological importance to it. The moderator band has been observed in the heart of *Echidna* and *Platypus* by Davies.[1] He called this band of cardiac muscle fibres as the 'septo marginal bundle' and further stated that the right limb of atrioventricular bundle descends down through it into the papillary muscles at the apical region of the ventricle. Gray[2] in the human heart has also described the continuation of the right limb of the 'A-V bundle' over the moderator band. The structure and disposition of the moderator band was observed in the heart of *Columba livia* in the hand cut sections (longitudinal and transverse), and the results have been confirmed by the study of serial sections of 10 to 15 μ in thickness.

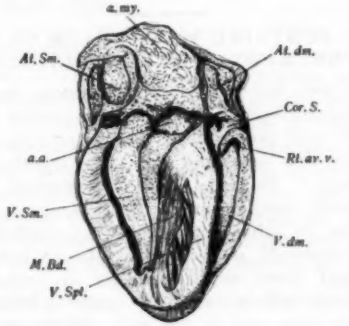

FIG. XXII

Section through the heart of *Columba livia*, × 3.

Abbreviations :—

a.a, aortic arch; *a.my.*, auricular myocardium; *At. dm.*, atrium dextrum; *Cor.R.*, coronary sinus; *M.Bd.*, Moderator band; *Rt.av. v.* Right atrio-ventricular valves; *V.dm.*, right ventricle; *V.sm.*, left ventricle; *V. Spt.*, ventricular septum.

The moderator band is attached at its anterior end with the cephalic portion of the septum ventriculorum. At this junction the muscle fibres of the septum fuse with those of moderator band. From this point it extends towards the apical portion of the left ventricle almost traversing the left ventricular cavity at its lower end and finally merging with the fibres of the left ventricular wall. Gaskell[3] and His[4] while studying the detailed anatomy of the vertebrate heart stated that the rate of the heart beat could be influenced by ganglia and nerves present at the junctions of atria and ventricles yet the rhythm movements of sinus venosus, atria and ventricles are due to the automatic contractile properties of the cardiac muscle fibres. The supporters of neorogenic theory have laid much stress on the presence of nerves and ganglia at the junctional site in the vertebrate heart. Recently Keith and Flack,[5] Adams,[6] Davies,[1] Prakash[7] are of one opinion that there is a specialised cardiac tissue responsible for initiation, conduction and control of cardiac impulse. The author has also described in detail the conducting system of the heart of birds (*Columba livia, Passer domesticus, Molpastes hæmorrous*) and is in full agreement with the above workers. A careful study of the serial sections reveals the presence of specialized fibres along the course of the moderator band continuous with a strand of Purkinje fibres lying at the base of the inter-atrial septum. For the rhythmic movement of the heart, the right and the left ventricles should beat together at the end of ventricular systole. It would only be possible when the cardiac impulse reaches the right and the left ventricles at the same time. In *Columba livia* the left ventricle is much larger than the right ventricle; in such a condition the wave of excitation obviously would have taken more time to reach the right ventricle. But the presence of specialised conducting fibres over the moderator band provides an additional pathway for the conduction of cardiac impulse from inter-atrial septum to the tip of the left ventricle. In these circumstances the impulse excites both the ventricles simultaneously. In the human heart (Gray[2]) and also in the heart of monotremes[1] the moderator band lies in the right ventricle which is larger of the two. Davies[1] also regarded it as "Peace maker"

because it prevents overdistension of the ventricle during ventricular systole. It was also suggested by him that the moderator band also spreads the wave of excitation over the entire ventricular area. On the basis of my observations in support of Davies[1] and Gray[2] it is concluded that it is the larger of the two ventricles (either the right or the left) which lodges the moderator band with specialised fibres to act as an additional conducting pathway for the propagation of wave of excitation from the inter-atrial septum to the left ventricle. In addition to it the moderator band in *Columba livia* provides mechanical support to the apex of the heart keeping it anchored to the massive septum ventriculorum.

My thanks are due to Dr. P. N. Mathur for his guidance and to Principal V. V. John for facilities provided.

Dept. of Zoology, TEJ SINGH.
Govt. College, Ajmer,
June 8, 1954.

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7. Prakash, R., *Ibid.*, Bengal, 1953, **6** (2), 113.

RECOVERY OF A FISHERY*

WINDOW-PANE oysters, *Placenta placenta*, were being commonly fished ten years ago between Sachana and Pindhara (North Coast of Saurashtra) in the Gulf of Cutch. During the last ten years, however, fishermen could not find live oysters on these grounds, while live oysters were being regularly fished off Poshitra (Bombay State) which is within a few miles of our grounds. Surveys conducted by the Departmental staff did not reveal any live mature stock. Early this year the author again conducted a survey between Pindhara and Panera and came across abundant stocks of mature and immature animals, both live and dead. In all, 850 oysters were collected from various localities and from the length-frequencies it appears that there are at least three fishable *categories* (not necessarily three age-groups): live oysters measuring between 7·1 to 8·0 cm. and 9·7 to 10·3 cm., and dead oysters measuring between 10·0 to 12 cm.

Size at first maturity is not yet known, but from the pearl-dust collected it is safe to conclude that the second category gives a higher yield. A rational exploitation would, therefore, be to fish oysters more than 8·0 cm. long.

A sample consisting of 354 oysters was obtained from the Poshitra fishermen where regular fishery is going on, and was measured in the same way. The range was 7·5 to 11·5 cm., with only one peak at 10·3. That is to say, the majority of them belonged to the second category. The percentage of animals less than 8·0 cm. was 22 per cent. On enquiry it was found that at first the fishermen were fishing in shallow waters where many oysters were small; but now they are fishing in deeper waters and are getting better yields of pearl-dust.

In my opinion, therefore, the only reason for the last ten "barren" years is that our fishermen fished indiscriminately and removed all the potential spawners during the last fishery. This may have been followed by one or two "poor spawning" years, and consequently it took a long time for the fishery tc recoup. Detailed investigations on the bionomics, especially the age and rate of growth, spawning season, etc., are in progress.*

S. V. GOKHALE.
Directorate of Marine Products,
Govt. of Saurashtra,
Jamnagar, *August* 23, 1954.

* Published by the kind permission of Saurashtra Government.

ECDYSIAL MECHANISM IN A DECAPOD, *PENAEUS INDICUS*

IT is well known that in arthropods the chitogenous epithelium forms a new cuticle at each moult and preparatory to this process the old cuticle gets separated from the underlying epithelium.[1] Recently Jones[2] described a new ecdysial mechanism in *Trombicula* in which unlike in other arthropods the epithelium in the premoult stages splits into an outer granulated layer which remains in contact with the old cuticle, and an inner cellular layer which gives rise to the new cuticle exposed at the time of moulting. The granulated layer appears to be shed along with the old cuticle. It is of interest to find in *Penæus* a similar histological differentiation associated with moulting. Here the chitogenous epithelium which is formed of a single layer of cells, unlike in the allied forms such as *Homarus*,[3] does

not retract from the overlying cuticle in the stages preceding moulting. In the above stages the epithelium shows a marked increase in number of cells formed by mitotic activity as may be inferred from the occurrence of groups of cells of smaller size in the epithelium. At a later stage it was noticed that a new row of cells is formed internal to the old epithelium from which it appears to originate (Fig. 1). A narrow space separates the two

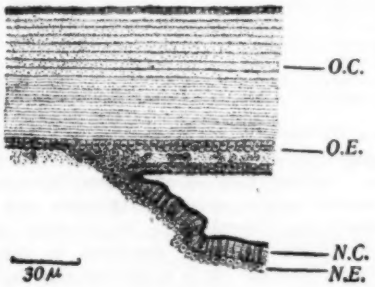

FIG. 1. Section of the late intermoult cuticle showing the new epithelium and cuticle. *N.C.*, New cuticle; *N.E.*, New epithelium; *O.C.*, Old cuticle; *O.E.*, Old epithelium.

cellular layers. It is suggestive that the inner layer of cells is produced by the division of the cells forming the chitogenous epithelium and subsequent migration to form an epithelial layer internal to the old one. This layer gives rise to the new cuticle in which both the epicuticle and endocuticle are distinguishable in the premoult stages.

In the above features *Penæus* differs from other crustaceans and insects so far studied, and recalls in some respects the condition noted in *Trombicula*.[2] The significance of the occurrence of such an ecdysial mechanism in *Penæus* is not obvious although a more extensive investigation of the ecdysial mechanism in arthropods would throw light on the above one.

Thanks are due to Dr. G. Krishnan, and Dr. C. P. Gnanamuthu, for encouragement and criticism during the course of the work.

Zoology Res. Lab., A. KRISHNA KUMARAN.
Madras University,
October 1, 1954.

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SOME NEW HOSTS OF *OROBANCHE*

IN continuation of the host list already published by one of the authors[1] this year again six new hosts of *Orobanche indica* as given below were recorded from Dholi (Darbhanga) in the first week of *February* 1954.

Botanical name	Family	Local name
Argemone mexicana L.	Papaveraceæ	Bharbhar
Blumea glomerata DC.	Compositæ	Kukroda
Lathyrus sativus L.	Leguminosæ	Khasari
Oxalis corniculata L.	Geraniaceæ	Amta
Polygonum plebejum var. *micranthema* Fran.	Polygonaceæ	Noni
Setaria italica Beauv.	Gramineæ	Kakun

Central Sugarcane Res. Station, Pusa, Bihar, *July* 27, 1954.
D. RAO.
N. C. JHA.

1. Rao, D., *Curr. Sci.*, 1953, **22**, 311.

HORTOMONE-A AND LATE PLANTING OF SUGARCANE

THE normal period of planting cane in Bihar ends by the middle of March and later plantings are apt to fail in the critical period of germination. The work reported here was undertaken with the object of studying the extent to which soaking of setts in Hortomone-A (I.C.I.) could offset the adverse effects of late planting by stimulating growth of roots (and of shoots as a consequence). Setts of variety B.O. 11 were soaked for 12 hours in a 0·011 per cent. solution of Hortomone-A (25 c.c. in 50 gallons) and planted in rows with four replications on April 2nd. The untreated setts were planted on March 25th. For comparison of germination performance, a periodical examination of roots was carried by uprooting 20 plants taken at random from the rows. The observations were continued as long as it was possible to dig up the plants with the roots intact. Severe infestation of termites and beetle grubs was noted at the last observation in the case of treated setts and as the roots were cut the values of length of roots at the 50-day interval may, therefore, be regarded as underestimations.

The χ^2 values in Table I will show that treatment effects were highly significant. Sett-roots in treated setts were comparatively fewer but sustained much better (being more numerous ultimately) and their mean length was always considerably greater. The number and mean

TABLE I

Effect of Hortomone-A on total numbers and mean lengths of roots

Series	Days from planting	Sett-roots		Comparisons	Shoot-roots		(Comparisons)
		Total No.	Mean length		Total No.	Mean length	
Treated :							
a	42	1125	8·48	59·7958 (*a* : *d*)	885	12·08	95·1988 (*a* : *d*)
b	46	922	7·43	47·9294 (*a* : *e*)	1009	17·85	30·8466 (*a* : *e*)
c	50	1067	6·93	76·6214 (*a* : *f*)	1179	12·45	51·5418 (*a* : *f*)
Control				87·0628 (*a* : *g*)			33·3189 (*a* : *g*)
d	42	1363	6·58	47·5467 (*a* : *h*)	650	6·71	51·3924 (*a* : *h*)
e	44	971	6·18	8·5771* (*b* : *f*)	864	9·25	157·0223 (*b* : *f*)
f	46	950	6·51	27·2647 (*b* : *g*)	743	9·70	164·3285 (*b* : *g*)
g	48	1124	6·08	19·7839 (*b* : *h*)	760	10·95	36·6114 (*b* : *h*)
h	50	817	5·56	15·0364 (*c* : *h*)	810	13·66	26·0019 (*c* : *h*)

* Indicates non-significant : All others are significant at 1% level.

length of the shoot roots were likewise significantly higher and the same held good for the germination (37·04 per cent. in treated setts as against 20·04 per cent. under control). Thus the utility of Hortomone-A treatment of setts as a measure for offsetting the adverse effects of late-planting is amply clear.

The authors are indebted to Sri. K. L. Khanna, Director, Sugarcane Research and Development, Bihar, for affording necessary facilities for the work and to Sri. M. P. Jha for the statistical analysis.

Entomology Section, Central Sugarcane Res. Station, Pusa, *April* 6, 1954.

S. B. D. AGARWALA.
S. N. PRASAD.

CRANIAL MORPHOLOGY OF *CLARIAS BATRACHUS*

THERE is not much literature available on the morphology of the skull of Indian catfishes. The pioneer work in this field has been that of Bhimachar[1] on eight Indian siluroid genera.

The observations of this note deal with the skeletal peculiarities of a primitive, bottom feeding catfish, *Clarias batrachus*. Skulls have been prepared after careful removal of the attached muscles; and alizarine whole mounts as recommended by Das and Rahim Ullah[2] have also been prepared.

While many siluroid skulls are partially ossified, that of *Clarias batrachus* has been found to be entirely so, there being a very well developed, broad, flattened cranial roofing, which provides a protective covering to the fish. The development of this shield can be easily associated with the sluggish and sedentary habits of the fish, because the skulls of the surface feeders like *Eutropiichthys vacha* and *Pseudeutropius* are all together devoid of this structure. It may also be of interest to note that a similar cranial shield in *Opiodon* and other Loricati was described by Gutberlet.[4] Woodward[6] found a similar condition in the skull of *Dactylopterus*. It is quite obvious that such roofing of the skulls of above-mentioned fishes is entirely due to convergence in evolution of bone.

Apart from the presence of a superficial covering which has been shown as a sign of primitiveness by Goodrich[3] in fishes, other primitive characters are also retained by *Clarias batrachus* as given below.

The skull is formed on the platybasic pattern, the vomer is toothed and the orbitosphenoid bone is very well developed. Tate Regan[5] has reported the absence of suprasphenoid (basisphenoid) in all the siluroids. But curiously enough, in *Clarias batrachus* this bone has been found to be completely fused with the parasphenoid along with its lateral margin between the foramina for V and VII nerves. This again is a sign of primitiveness.

It has been stated by Bhimachar[1] that excavations in the hinder region of the siluroid skull, and the development of supraoccipital process can be taken more or less as a measure of progressive growth. It has been found in *Clarias batrachus* that the spina occipitis is not visible externally on the dorsal surface but is completely fused on the ventral side in a form of shelf attached to the posterior occipital region of the cranium. Moreover, feeble development of superior and inferior limbs of post-temporal and the feebler attachment with the 'complex anterior vertebra' further points to the primitive nature of the skull of *Clarias batrachus*.

The author's thanks are due to Prof. D. R. Bhattacharya for his kind encouragement and Dr. S. K. Dutta for his helpful guidance.

Dept. of Zoology, ANJNI KUMAR.
C.M.P. Degree College,
Allahabad, *August* 11, 1954.

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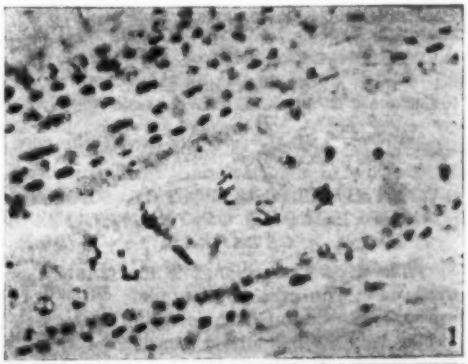
MITOSIS IN THE POLLEN MOTHER-CELLS OF *PENNISETUM RAMOSUM* ($2n=10$)

MITOSIS and other irregularities resulting in the breakdown of microsporogenesis, have been reported recently by Nygren[1] in *Calamagrostis* which is a diplosporous apomict. Both Gustafsson[2] and Stebbins[3] have pointed out that meiotic irregularities, except those peculiar to hybrids, are usually absent in aposporous apomicts. However, in *Pennisetum ramosum* which shows a tendency towards apospory, there is a breakdown of microsporogenesis resembling that described for *Calamagrostis*.

Plants of *P. ramosum*, a native of Central Africa, which had been raised from seeds received from Kew Gardens, England, were being grown in the green-house on the Berkeley campus of the University of California. Only one of these plants showed normal microsporogenesis and good pollen fomation while the rest exhibited various abnormalities of PMC meiosis leading to the formation of completely inviable pollen. It is interesting to note that the irregularities which form such a conspicuous feature of the PMC meiosis were not found on the female side in the EMC meiosis.

This breakdown of meiosis and the consequent degeneration of pollen mother-cells is brought about by the formation of univalents, tetraploid and hexaploid pollen mother-cells (brought about probably by pre-meiotic disturbances), fragmentation of chromosomes, resting PMCs, mitosis, etc. The most commonly observed abnormality, however, is the occurrence of mitosis in PMCs. Entire locules containing PMCs undergoing mitosis were observed. Figure 1 is a photomicrograph of a paraffin section showing an anther locule with PMCs in mitosis. The mitotic chromosomes are seen forming regular equatorial plates and their centromeres are clearly visible. Figure 2 is an



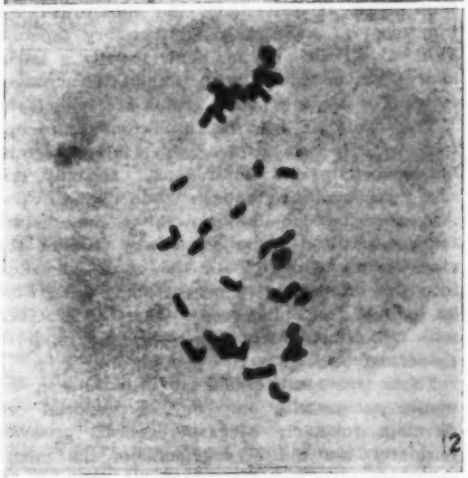


FIG. 1. Anther locule showing mitotic chromosomes in PMCs. Resting nuclei along with mitotic PMCs to be noted.

FIG. 2. Aceto-carmine smear preparation of a hexaploid PMC showing about 30 mitotic chromosomes in anaphase.

aceto-carmine smear preparation showing a hexaploid PMC with about 30 mitotic chromosomes in anaphase. Although many anther locules showed only mitotic PMCs, other locules showing both PMCs in mitosis and PMCs with other irregularities such as the resting nuclei, were also found in some cases (Fig. 1). Features of apospory and the causes of the meiotic breakdown will be reported separately.

My grateful thanks are due to Prof. Stebbins of the University of California for kind guidance.

Dept. of Botany, K. N. NARAYAN.
Central College, Bangalore,
October 10, 1954.

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2. Gustafsson, A., *Lunds Univer. Arsskr. N. F. Avd.*, 1947, **2**, 43 (2), 71.
3. Stebbins, G. L., *Variation and Evolution in Plants*, 1950, Columbia Univ. Press, 643.

CONTRIBUTIONS TO THE FLORAL MORPHOLOGY OF *TERMINALIA CATAPPA* L.

Terminalia catappa belongs to the family Combretaceæ. The present note deals with certain aspects of the floral morphology of this species.

The wall of the anther consists of three to four layers of cells under the epidermis; the innermost of these forms a secretory tapetum (Fig. 1). Pollen tetrads show usually a tetrahedral, but occasionally an isobilateral arrangement. The mature pollen grains are binucleate.

The ovary is inferior, unilocular and contains usually two ovules which are bitegmic, crassinucellate and anatropous. In only one case three ovules have been found in the ovary. An extensive cup-like growth of the chalaza takes place and forms the lower part of the ripe ovule. Only one of the ovules develops into a seed; the rest degenerate and are crushed by the developing seed. Ovary is provided with unicellular hairs which are the modified epidermal cells.

There is a multicellular archesporium in the ovule, but usually only one archesporial cell develops further. Megasporogenesis proceeds normally and the arrangement of the megaspore tetrad is linear or T-shaped (Figs. 2, 3). The development of the megagametophyte corresponds to Polygonum type. The synergids sometimes show a filiform apparatus and their upper parts persist for a long time. The antipodals degenerate early (Figs. 4, 5, 6). In one case two megagametophytes have been observed in a single ovule (Fig. 7). At various stages of megagametophyte development the nuclei of the gametophyte were found to disintegrate (Figs. 8, 9).

Endosperm is nuclear (Fig. 10), and the first division of the primary endosperm nucleus takes place before that of the oospore. Endosperm is completely consumed by the growing embryo.

Usually only one embryo develops in an ovule, and the development of the embryo seems to take place according to Solanad type.

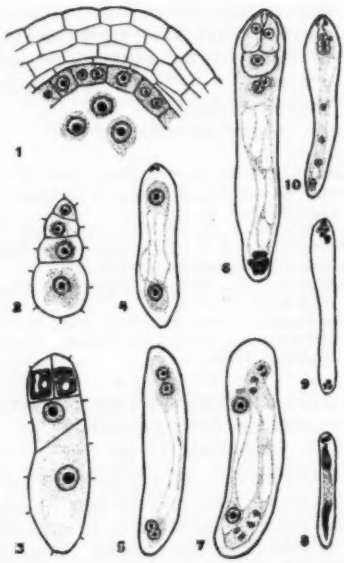

FIG. 1. Anther lobe showing the epidermis, middle layers and tapetum, × 215. FIG. 2. A linear tetrad, × 243. FIG. 3. A T-shaped tetrad, × 243. FIG. 4. Two-nucleate megagametophyte, × 121. FIG. 5. Four-nucleate megagametophyte, ×121. FIG. 6. Eight-nucleate megagametophyte, × 121. FIG. 7. Two megagametophytes in an ovule, ×121.—one ovule four-nucleate with all the nuclei dividing, one two-nucleate. FIG. 8. Two-nucleate megagametophyte with both the nuclei getting degenerated, ×121. FIG. 9. Mature megagametophyte showing all the nuclei degenerated, × 50. FIG. 10. Nuclear endosperm with a three-celled embryo, × 50.

My sincere thanks are due to Prof. L. N. Rao for kind encouragement.

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September 10, 1954.

UNRECORDED HOST PLANT OF *PENTALONIA NIGRONERVOSA* COQ.

Pentalonia nigronervosa Coq. (Aphidæ, Rhynchota), the vector of Bunchy top disease of Banana, is known to have only a limited range of alternate host plants. This aphid has been recorded only from plants belonging to the natural order Musaceæ[1] and Zingiberaceæ.[2,3] In South India the insect is also known to transmit a serious mosaic disease of cardamom.[4]

During the course of a survey of alternate host plants of *Pentalonia nigronervosa* in the high ranges of Travancore, large numbers of both alate and apterous forms were noticed profusely breeding inside the leaf-sheaths of both *Colocasia antiquorum* Schott., and *Alocasia*

macrorrhiza Schott. More than 80 per cent. of the plants examined revealed the presence of this aphid and large numbers were noticed during February to May.

The presence of this aphid on plants belonging to Aroideæ recorded here for the first time is interesting because earlier workers were led to believe that this insect could not thrive on hosts other than those belonging to the natural order, Musaceæ and Zingiberaceæ.[1,5]

Further observations on the distribution of this aphid in different parts of the State in relation to the new alternate host are in progress.

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September 21, 1954.

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POLYTHENE AND HEAVY METALS

THE possibility of heavy metal contamination from plastic containers (American) was studied earlier by Dozer and Dole.[1] In the present study, polythene wash-bottles (Fibernyle Ltd., London) were tested biologically for their heavy metal impurities, using two strains of *Aspergillus niger* van Tiegh.—'M' and 'M.U.B.L.1.'.

After thorough washing with soap and water, the wash-bottles were soaked in strong chromic acid cleaning solution for a week and copiously washed with glass-distilled water. Subsquently they were rinsed in double- and treble-distilled water. (All-glass pyrex stills were used for distillation.) When dry, they were filled with known volumes of slightly acid thrice-distilled water, closed well and set aside for three weeks in a dustless chamber. Later, the water was transferred to clean pyrex beakers and concentrated by evaporation (100 ml. evaporated to 10 ml.). Heavy metal deficient media with the control (+ all) and blank (— all) were prepared as in routine studies made in this laboratory.[2] Two batches were kept, one receiving 0·5 ml. per flask of thrice-distilled water stored in the usual, clean, pyrex containers, and the other, a similar quantity of the water sample from the wash-bottles. The sterilized flasks were inoculated with a spore suspension of the 'M' strain for detecting iron, zinc, copper and molybdenum, and that of 'M.U.B.L.1.' for manganese assay. Cultures were run in duplicates. After the usual incubation period, the two strains showed the characteristic growth forms and sporulation in the respective series (+ all, — Fe, — Zn, — Cu, — Mn and — Mo)[2] of both the batches, showing thereby no contamination from the wash-bottles. It appears, therefore, that polythene containers (moulded out of I.C.I. Polythene sheets) may conveniently be used in biological studies with the above five heavy metals.

The author thanks Prof. T. S. Sadasivan for getting the wash-bottles from the U.K. and for suggestions.

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September 29, 1954.

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pF-WATER RELATION IN HEATED SOILS

HEATED soils have higher permeabilities for water than normal soils.[5] Heating promotes aggregation of soil particles by the dehydration of clay. Accompanying aggregation there should be variation in pore volume and pore size distribution. It has been shown by actually measuring the capillary and total pore volumes that on heating a soil above 60° C. the capillary pore volume decreases and the non-capillary pore volume increases continuously. By studying the pF-water relation in soils, Baver[1] has shown that the permeability of a soil is dependent not only on the non-capillary pore volume but also on the pF of inflexion point. With a view to correlate the permeability changes in heated soils with the changes in pF-water relation, the normal and heated soils were subjected to tensiometer studies.

The Gangetic alluvial soil of Delhi (India), which was used in the earlier investigation[5] was employed in the present work. The soil was heated for 3½ hours to 60° C., 150° C., 225° C., 360° C., 600° C., 650° C., 800° C. and 1,000° C. The tensiometer technique described by Richards[6] was employed. The soil water was estimated by oven-drying. The non-capillary pore volume was determined from the capillary and total pore volumes in accordance with Zunker's formula. Capillary pore volume is twice the

hygroscopicity which is equal to the amount of water taken up by the soil at relative humidity of 94·3 per cent.[2] This was determined by using a quartz fibre spring balance.[4] The total pore volume was determined from the real and apparent densities.

The pF-water relation reveals the following interesting changes (Table I). The amount of water withdrawn from the soil from zero tension to inflexion point (w. in g.) is the same up to 60° C. and it steadily increases from 60° C. to 1,000° C. The pF of inflexion point first increases upto 60° C., next decreases slightly upto 225° C. Later it decreases more rapidly upto 650° C. From 650° C. to 1,000° C. the decrease is less rapid.

TABLE I

Temperature of heated soil °C.	wt. in g. per 100 c.c. soil	pF of inflexion point	Porosity factor	Non-capilary pore volume in 100 c.c. soil	Permeability coefficient cm./hour
N	20·94	2·15	9·74	45·11	5·95
60	20·97	2·20	9·53	43·98	5·60
150	21·46	2·18	9·84	45·67	6·25
225	21·59	2·18	9·90	45·76	6·80
360	21·76	2·13	10·22	48·05	10·70
600	22·87	1·97	11·61	49·77	16·90
650	23·07	1·98	11·65	50·28	18·65
800	24·11	1·95	12·37	52·08	17·45
1000	24·30	1·83	13·27	54·20	15·60

Baver has assumed that the amount of water withdrawn from a soil from zero tension to inflexion point represents the non-capillary pore volume. The permeability is directly proportional to this quantity and inversely proportional to the pF of inflexion point. Extending these generalizations to heated soils the following interesting conclusions emerge. The amount of water withdrawn from soil from zero tension to inflexion point increases on heating the soil, Table I. Similarly the permeability coefficient for water also increases. The relation between permeability and the amount of water withdrawn from zero tension to inflexion point is similar to the relation between permeability and non-capillary pore volume. It follows from this similarity that Baver's assumption is justifiable.

The porosity factor is the ratio of the amount of water withdrawn from zero tension to inflexion point and the pF of inflexion point, and it first decreases with temperature upto 60° C. and next increases up to 225° C. Above 225° C., it increases more rapidly. This variation is similar to the variation of permeability coefficient with temperature of heating the soil up to 650° C. This indicates that permeability is dependent upon the combined effects of the pF of inflexion point and the amount of water withdrawn from zero tension to inflexion point. This conclusion is amply borne out by the fact that the permeability-porosity factor relation is linear up to 650° C. Above 650° C., it does not hold good. This apparent anomaly is probably due to the decrepitation in water of strongly heated soil particles analogous to drastically heated silica gel decrepitating in water. The permeability is really that of changed system. As such there is no meaning in extending the above relation to soils heated above 650° C.

Whether the amount of water withdrawn from zero tension to inflexion point is equal to the non-capillary pore volume or is only a measure of it has also been elucidated. The relation indicates that the two quantities are not equal and that the latter is 2·15 times the former.

Though the pF of inflexion point is an important contributory factor in determining permeability, the physical significance is very interesting. In a soil the pores exist in the form of continuous channels. In random distribution these channels have a number of constrictions producing cavities or ink bottle-shaped pores. The cavity concept was first suggested by McBain[3] and later elaborated by Rao, K. S.[4] These constrictions are responsible for producing the sorption-desorption hysteresis which is a static phenomenon connected with the equilibrium between liquid and vapour phases.

Permeability is essentially a phenomenon of liquid flow in pores and is governed by Poiseuille's Law. As water flows through the constricted channels the constriction or necks offer the maximum resistance to flow and the rate of flow is really governed by the diameter of these necks. Assuming that the pF of inflexion point signifies the neck diameter, the variation in permeability with variation in pF of inflexion point is easily intelligible. The pF of inflexion point in the pF-water curves denotes the most predominant pore size. According to the cavity concept, if the pF of inflexion point stands for neck diameter, the amount of water that can be withdrawn from the soil without changing the pF at the inflexion point appreciably, represents the amount of water entrapped by the cavities. A detailed account of these interesting results is being published elsewhere.

The authors are grateful to Dr. D. S. Kothari, for his keen interest in the work.

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Defence Science Organisation,
Ministry of Defence,
New Delhi, *September* 8, 1954.

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INTERNODAL LENGTH AS AN INDEX OF MEASUREMENT FOR DROUGHT RESISTANCE IN GROUNDNUT

IN Hyderabad State groundnut is grown as a rainfed crop in the kharif season, and bunch varieties are a rule rather than an exception in sandy soils (locally known as 'Chalkas') of the Telingana Districts which are very poor in their moisture-holding capacity (20 per cent. approximately). Sowing commences from the third week of June with the onset of the monsoon and extends to the second week of July and the crop comes to harvest by the end of October. Usually there is a period of twenty-five to thirty non-rainy days in September and October at the cessation of the south-west monsoon, coupled with high temperatures, and this period coincides with the development of the pods underground. It is during this period that the plant requires optimal conditions for the successful development of the pod and any deviation from the normal, adversely affects the filling of the pods, resulting in low yields.

Different indices[1,2,3,5–8] have been used to measure the resistance to drought in different crops. In a varietal test of 7×6 randomised blocks sown in a chalka plot comprising of the following seven bunch varieties, *viz.*, Kopargaon-1, Spanish Improved, Spanish-9, Spanish-5, Tindivanam-2, Kopargaon-3 and Local bunch, the number of plants wilted, out of a total population of 2688 per variety, during the period of soil and atmospheric drought, were noted and the data shown in Table I. It was found that Kopargaon-1 was the most resistant with the least number of wilted plants while Kopargaon-3 was the most susceptible to drought. In addition, some of their physiological attributes such as leaflet length and width, leaflet area, internodal length and the total number of shoots per plant were recorded. Five plants from each replication were selected at random and for the measurement of internodal length four shoots consisting of the main axis and three randomly selected primaries from each plant have been taken and on each of these four shoots, four internodes at random were measured, i.e., sixteen internodal measurements. The capacity of the plants to withstand wilting was found to be associated with plants having shorter internodal length. When correlation coefficients were calculated[4] between the number of wilted plants and other physiological attributes, it was found that there exists a highly significant positive correlation ('r' : 0·7665) between the internodal length and the number of wilted plants. Internodal length can reasonably be assumed as an index for comparing the capacity of the plants to withstand drought. This relationship was found to hold good only when comparisons are made amongst bunch varieties but not between bunch and spreading varieties.

Acknowledgement is due to Dr. L. G. Kulkarni, the then Oil Seeds Specialist, for initiating the problem and for guidance at the early stages.

TABLE

Analysis of variance for the number of wilted plants

Due to		D.F.	S.S.	M.S.S.
Totals	..	41	325192·0	7931·5
Varieties	..	6	321899·6	53649·9
Blocks	..	5	978·8	195·7
Errors	..	30	2313·6	771·2
			S.E. :	16·032
			C.D. :	32·7

Kop–3	Sp–5	T.M.V.–2	Sp–9	Local	Sp. Imp.	Kop–1
310·5	258	185·5	108	103·6	89·6	59·6

Oil Seeds Lab., V. L. NARASIMHA RAO.
Main Expt. Station, CLARENCE A. GIDEON.
Himayatsagar, Hyderabad (Dn.),
August 16, 1954.

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REVIEWS

The Collected Papers of Peter J. W. Debye. (Interscience Publishers, Inc.), 1954. Pp. xxi + 700. Price $ 9.50.

This selection of classical papers by Professor Debye was presented to him by his pupils and well-wishers on his seventieth birthday. The selection was made by Professor Debye himself. The papers originally published in German and Dutch have been translated into English, while those in English have been reproduced directly from the original journals. A more appropriate title would have been "Selected Papers", for it would avoid persons like the reviewer being disappointed when they do not find a particular paper of Debye which they would like to refer to.

Broadly, the papers may be divided into four types, dealing respectively with X-ray scattering, dipole moment and polarisability, electrolytes, and scattering of light. In each of these fields, Debye has been the originator of brilliant ideas which have opened up new vistas in science. A brief survey wherein the contributions of Debye are viewed in the light of later developments that came out of them serves as an admirable introduction to the collected papers.

One cannot but admire the versatility of this genius, who has contributed something to almost every branch of physics and physical chemistry. Science to the majority is perhaps only a cold business of logic and symbols and experiment; but there are also a few to whom it can be a creative art as well. Of this choice company, Debye is a name to reckon with, as is that of Raman in our own country.

G. N. RAMACHANDRAN.

The Physics of Experimental Method. By H. J. J. Braddick. (Chapman & Hall), 1954. Pp. xx + 404. Price 35 *sh.*

As Professor Blackett says in his preface, far fewer text-books suitable for the advanced student have been written on the methods of experimental physics than on special branches of physical knowledge. Perhaps the only other book available is Strong's *Modern Laboratory Practice*. Braddick's approach to the subject is however from a slightly different angle—the emphasis being on the basic principles rather than on detailed techniques. Strong is an indispensable companion to be had by the side in the laboratory, but Braddick must be read and mastered before a student takes up real experimental work.

The first chapters of the book discuss the errors involved in physical measurements and the methods of estimating them and the reduction of required quantities from the experimental data. Even during the brief period that the reviewer had the book with him, the students in his laboratory have made use of this section a number of times in connection with their researches. It is unfortunate that this aspect of experimental physics is rarely touched upon in the teaching of physics in our country. The next few chapters are concerned with the design of apparatus and a discussion of the properties of materials which go into their construction. Vacuum technique is discussed in a brief chapter of forty pages. The succeeding chapters deal with electrical and electronic techniques, and with optics and photography. The book ends with an account of special techniques in nuclear physics.

Every chapter is studded with choice and valuable information. In particular, the portion dealing with electronics should be read by every student taking to research in experimental physics. Dr. Braddick has indeed done an immense service to the younger workers in making available to them a compendium of knowledge which otherwise they had to obtain bit by bit in the hard school of experience.

G. N. RAMACHANDRAN.

Relays for Electronic and Industrial Control. By R. C. Walker. (Chapman & Hall), 1953. Pp. xi + 303. Price 42 *sh.*

The part played by relays in electrical engineering practice is a considerable one, whether the purpose is safety, sequential operation or automatic control. The paucity of books on this important subject has been felt for sometime and the late R. C. Walker has done a distinct service by bringing together in cogent form the extensive literature on the subject in the book under review.

The relay is essentially a low power device for controlling large power or performing pre-

arranged operations. In the main, it may be electromagnetic, thermal or electronic. It can have other features like polarity, speed and delay.

The electromagnetic type consists of coil and iron circuits and contacts, and their design is treated in Chapters 2-4. Special considerations with this type of relay are the varying inductance due to the movement of the core and the difference between the closing and holding currents, which governs the stability of the relay. The contacts offer interesting electrical and mechanical problems like contact resistance, optimum pressure, arcing, bounce and chatter. The author has discussed these design features starting right from the first principles.

Chapters 5 and 6 deal with the different types of relays used in D.C. and A.C. operation. The telephone relay, mercury switch, micro-relay and galvanometer relay are the typical D.C. examples; the last two are particularly suited in sensitive operations with currents in the range of microamperes. The induction, balanced beam, astatic voltage relays are some of the important A.C. types considered. In A.C., additional problems like response to frequency and ripple come up and these, together with the elements of protective systems in power circuits, are discussed.

In connection with the speed of relays, the Siemen's and Carptener types, useful in millisecond ranges, are discussed. Chapter 8 is devoted to a discussion of time elements in relay operation or release. Where the time element is fairly large, this can be achieved by mechanical devices. Some thermal and electronic artifices are also considered. The thermistor is another useful component in providing delayed switching.

The last two chapters deal with the operation and control of relays like latching, interlocking and mastercontrol and their miscellaneous applications like response to nth impulse, control of acceleration and torque and battery charging devices.

The main appeal of this book will be of course to the engineer and instrument specialist. For this reason, perhaps some of the discussions could have been more analytical like, for instance, the micro-relay movement or the high speed relays. But this is partly compensated by the references to be found at the end of each chapter.

On the whole, the author and the publishers are to be congratulated for bringing out a very readable account of a subject of great utility and interest.

K. S. CHANDRASEKARAN.

Annual Review of Biochemistry, Vol. 23, (Published by Annual Review Inc., Stanford, California), 1954. Pp. ix + 636. Price $ 7.00.

The present volume of the *Annual Review of Biochemistry* is as comprehensive as its predecessors in the treatment of the various topics in biochemistry. The prefatory chapter, which has been an innovation since last year, has been written by the veteran Dr. Karl Thomas, who in a very lucid autobiography has also reviewed fifty years of biochemistry in Germany. The succeeding chapters on biological oxidations, proteolytic enzymes, chemistry of the carbohydrates, nucleic acids, carbohydrate metabolism, chemistry of proteins, peptides and amino acids, fat-soluble vitamins, water-soluble vitamins, nutrition, the biochemistry of muscle and of hormones, the clinical applications of biochemistry, mineral metabolism, thyroid hormones and iodine metabolism, metabolite antagonists, and non-oxidative and non-proteolytic enzymes, have been written by authors, who have been active investigators in these special fields of study. It is noticed, however, that some of the authors have not gone through the literature for the whole year before writing their respective review articles. A few have done up to September, while others have gone up to October or November. Jean Roche and Michel in their article on thyroid hormones and iodine metabolism state that they have included the literature only until July of last year. Since the authors of the various chapters of the annual review are different from year to year, it appears desirable to have a common date for the coverage of literature, though not necessarily the last month of the year under review.

The special articles such as metabolite antagonists, clinical applications of biochemistry and the recent advances in the biochemistry of muscle and of cancer are very welcome features of this volume. Mention may also be made of some of the highlights such as the excellent discussion of fatty acid oxidation, nerve patterns of carbohydrate dissimilation, the exhaustive treatment in two chapters of the water-soluble vitamins and the biosynthesis and metabolism of phosphorus compounds. The extensive use of tracer technique employing radioactive carbon, sulphur, phosphorus and iodine labelled compounds is also clearly seen in many articles of this annual review. The volume as a whole maintains a high standard for critical appraisal of world biochemical literature, and should prove indispensable to every biochemist whether he is engaged in teaching or research.

P. S. SARMA.

Methods and Principles of Systematic Zoology. By E. Mayr, E. G. Lenslay and R. L. Usinger. (McGraw-Hill), 1953. Pp. 328. Price $ 6.00.

The book consists of 17 chapters arranged in three parts. Every page is packed with information which the authors have gleaned during their long periods of teaching. The information is of a kind the student rarely gets from text-books or other books of reference.

The authors have clearly dealt with the value of the study of classification, the definition of species, the infraspecific and supraspecific categories and the different sets of morphological differences that have to be studied in different populations. Chapters 7-14 will be invaluable to students and staff who have a research bent. Analyses of quantitative data, presentation of findings and preparation of taxonomic papers are topics which make this book indispensable to them. Chapters 10-17 dealing with zoological nomenclature will be indispensable to authors in the matter of naming up new species.

In short, the authors as well as the publishers must be thanked for not only the contents of the book, its treatment, its bibliography, its glossary of technical terms and its index, but also for its most attractive get-up. Any college or research library will be the poorer without this book.

C. P. GNANAMUTHU.

International Review of Cytology, Vol. II. (Academic Press, Inc.), 1953. Pp. vii + 545. Price $ 11.00.

The second volume of the *International Review of Cytology* reflects the increasing interest evinced by biochemists and biophysicists alike in problems centering around the gene and its mode of action. For some time now the attack on problems in cell physiology has been on a broad front employing the techniques and methodology of different disciplines. This has resulted in advances in several directions. It is not surprising, therefore, that as in the preceding one, the reviews in this volume also are on a variety of topics like the cell nucleus, electron microscopy, cytochemistry, transport phenomena and growth and differentiation.

Perhaps the most stimulating contribution is that of Glick which critically appraises the current approaches in quantitative histo- and cytochemistry. His conclusions deserve attention. Regarding the judicious use of diverse methods, he observes: "The usefulness of the imperfect method lies in an understanding of the boundaries of its effective application, and the good judgment to confine its use to those areas in which the methodological uncertainties will not confuse the interpretations" (p. 470). Glick believes that progress would be possible only if better and finer tools are fashioned and the existing tools and techniques refined.

Some investigators (Swift, p. 67), have expressed the hope that quantitative studies would remove subjectivity, which has been considered one of the drawbacks of formal cytology. The recent investigations reviewed in the volume do not however, justify such a hope. Interpretations as distinct from observations still remain subjective.

Classical cytology has been static for the past many years. The recent advances in cell physiology reveal the necessity for some bold generalizations. The volume under review is a mine of information and should find a place in any good scientific library.

M. K. SUBRAMANIAM.

Discovery Reports, Vol. 27. (Issued by the National Institute of Oceanography.) (Cambridge University Press), 1954. Pp. 218. Price 78 *sh.*

The present volume of *Discovery Reports* consists of three parts:

Part I.—The Siphonophora of the Indian Ocean are reported on by A. K. Totton of the British Museum. Only those who have ever reported on the taxonomy of planktonic forms can adequately appreciate the patience and methodical listing and description of these easily fragmented forms occurring in different stages of development. To us in India, where zoology is confined mainly to colleges and university departments, Totton's discussion of the relationships of the Siphonophora to the rest of the Cœlenterata would be of interest—especially as Hyman, whose book is used in most institutions, considers the primordial ancestor of all cœlentera as medusoid in form. He divides the "Siphonophores" into two entirely distinct orders, the Chondrophora including *Velella*, *Porpita* and *Porpema*, and the Siphonophora, and regards the former as highly modified Tubularid hydroids and the latter as meduoids with polypoid larval stages. This would lead one to picture the original ancestor of both the orders and therefore of the cœlenterata as a whole, as of a polypoid form. The problem is really a "vexing" one, since the medusoid plan of body can be derived from that of polypoid and *vice versa*, since both can give rise to buds and since the simplest larvæ of hydroid forms are pelagic.

The entire account is well illustrated by excellent figures and plates.

Part II.—The pelagic mollusca of the Benguela current and the reproductive system of *Limacina bulemoides* are reported on by M. E. Morton. Of the eleven species of pelagic mollusca described, only two closely allied species have been recorded from Madras. The account of the depth distribution of these molluses will be of interest to students of the plankton of the Indian coast.

Part III.—The circumpolar continuity of Antarctic plankton species by A. de C. Baker is of interest in establishing an idea expressed by several others, as a fact of observation.

This volume as a whole, like the others, does credit to both the authors and the publishers, and must be included in every zoology library.

C. P. GNANAMUTHU.

Genetic Homeostasis. By L. Michael Lerner. (Oliver & Boyd, Edinburgh), 1954. Pp. vii + 134. Price 12 *sh.* 6 *d.*

To those who are not familiar with the term 'homeostasis', the title of the book appears somewhat forbidding. However, the author in his introductory chapters soon clears this difficulty, by defining homeostasis as the property of an organism to adjust itself to variable conditions. It is the self-regulatory mechanism of an organism which permits to stabilize itself in fluctuating inner or outer environments. The word homeostatis was coined by W. B. Cannon as early as 1932 in the field of physiology, as 'the totality of steady states maintained in an organism through the co-ordination of its complex physiological process'. Once the hurdle of the title is surmounted it is easy to understand genetic homeostasis as the elaboration of the idea of 'genetic inertia' postulated by Darlington and Mather in 1947. It is the 'property of the population to equilibrate its genetic composition and to resist sudden change'. The author demonstrates that Mendelian populations possess self-regulating properties to establish a connection between genetic and developmental homeostasis and to suggest that heterozygosity provides a basis for both phenomena. He next considers the consequences of these points for evolution and breeding.

The ideas propounded are by no means original. Mather and his collaborators brought out the relationship between individuals and population as early as 1943. The framework of the book is old. The label is new. The originality lies in that the chief emphasis is placed on data from artificial selection from domestic animals, including previously unpublished data from the author's own laboratory.

The book brings together post-war data on population genetics and shows that the 'best adapted form in a species is usually one that is close to the average in all quantitatively varying characters. The superiority of heterozygous over homozygous genetypes and the role of selection in maintaining heterozygous forms by means of rejection of deviant homozygous types has great importance in breeding. The book is well illustrated and has many informative graphs and diagrams.

E. K. JANAKI AMMAL.

Proceedings of the Fifth Conference on Cotton Growing Problems in India, March 1952. (Published by the Indian Central Cotton Committee, Bombay), 1953. Pp. xii+116. Price Rs. 4.

A perusal of the proceedings of the recent conference on cotton-growing problems in India, published recently, shows that this conference has fulfilled the chief objects for which such conferences are generally held; firstly, to provide a common platform for research workers engaged in various branches of science connected with cotton-growing to discuss problems of mutual interest to them, and secondly, to afford an opportunity for junior workers to meet the seniors in a scientific atmosphere and discuss problems with an open mind unbiassed by administrative considerations.

Thirty-four papers—9 on cotton breeding and genetics, 11 on cotton agriculture, 3 on statistics, 8 on cotton technology and 3 on cotton pests and diseases—were read and discussed. Summaries of these papers and discussions on each would certainly be of value to other workers in their respective fields who had not participated in the Conference. As was observed by the President in his address, the programme dealt with various subjects related to cotton, for instance, plant breeding and genetics, agronomy of cotton, diseases and pests, cotton statistics and last, but not the least, technological research on cotton. No one can expect that one can be an expert in all these branches. In view of this, it is suggested that full papers may be published instead of summaries, as otherwise, a non-participant in the conference may not be able to follow the discussions with advantage.

C. NANJUNDAYYA.

Books Received

Nuclear Species. By H. E. Huntley. (Macmillan & Co.), 1954. Pp. xix + 193. Price 21 *sh.*

Chemical Pathways of Metabolism, Vol. II. Edited by David M. Greenberg. (Academic Press Inc.), 1954. Pp. viii + 383. Price $ 9.50.

Entire Functions—Pure and Applied Mathematics Series of Monographs and Text-Books, Vol. V. By R. P. Boas Jr. (Academic Press, Inc., N.Y.), 1954. Pp. vii + 276. Price $ 6.00.

Distribution of Radio Brightness on the Solar Disk. (Special Report No. 4.) *Interstellar Hydrogen.* (Special Report No. 5.) (Published by Union Radio-Scientific Internationale, Brussels, LE.), 1954. Pp. 72. Price 14 *sh.* 6 *d.*

Physiology of Insect Metamorphosis—Cambridge Monographs in Experimental Biology. By V. B. Wigglesworth. (Cambridge University Press), 1954. Pp. vii + 151. Price 12 *sh.* 6 *d.*

Acoustics. By Leo L. Beranek. (McGraw-Hill), 1954. Pp. x + 481. Price $ 9.00.

Chemistry of Heterocyclic Compounds—Heterocyclic Compounds with Indole and Carbozole Systems, Vol. VIII. By W. C. Sumpter and F. M. Miller. (Interscience Publishers, Inc.), 1954. (Agents in India: Asia Publishing House, Bombay.) Pp. xii + 307. Price $ 10.00.

Electronic Measuring Instruments. By E. H. W. Banner. (Chapman & Hall), 1954. Pp. xiv + 395. Price 45 *sh.*

Physical Chemistry. By A. J. Rutgers. (Interscience Publishers, Inc.), 1954. Pp. xix + 804. Price $ 8.50.

Technique of Organic Chemistry—Micro- and Semi-Micro Methods, Vol. VI. By Nicholas D. Cheronis. (Interscience Publishers, Inc.), 1954. Pp. xxiii + 628. Price $ 12.00.

Colloid Chemistry. By B. Jirgensons and M. E. Straumanis. (Pergoman Press), 1954. Pp. xvi + 420. Price 40 *sh.*

High Polymers—Cellulose and Cellulose Derivatives, Vol. V, Part I. Edited by Emil Ott, Harold M. Spurlin and Mildred W. Grafflin. (Interscience Publishers, Inc.), 1954. Pp. xvi + 509. Price $ 12.00.

New Instrumental Methods in Electrochemistry. By Paul Delahay. (Interscience Publishers, Inc.), 1954. (Agents in India: Asia Publishing House, Bombay.) Pp. xvii + 437. Price $ 11.50.

Recent Progress in Hormone Research—The Proceedings of the Lawrentian Hormone Conference, Vol. X. (Academic Press, Inc.), 1954. Pp. 511. Price $ 9.80.

The Fruit, the Seed and the Soil—Collected Edition of the John Innes Leaflets, Nos. 1-9. Edited by W. J. C. Lawrence. (Oliver & Boyd), 1954. Pp. viii + 92. Price 5 *sh.*

SCIENCE NOTES AND NEWS

Non-Poisionous Preservative for Sugarcane Juice

S. V. Ramanayya and M. S. Ramachandramurthy, Etikoppaka Sugar Factory, Etikoppaka, report that thymol ($C_{10}H_{14}O$) has been found to be very efficacious as antiseptic and specific for the preservation of sugarcane juice during sampling and analysis in factories. By using thymol, instead of the basic and neutral acetates of Pb and iodides and chlorides of Hg, the materials now in use, large quantities of the juice need not be thrown away as at present.

Bicapillary Apocarpous Gynoecium in *Crotalaria laburnifolia* L.

Sri. K. V. Sambasiva Rao, Department of Botany, Sri Venkateswara College, Tirupati, reports that he came across a case of bicarpellary apocarpous gynœcium in *Crotalaria laburnifolia* L. The usual single carpel is borne on a sufficiently long cylindrical stalk, the gynophore. The gynophore in the abnormal flower is flattened, showing a double nature with a prominent median groove running right from the very base to apex, where it is branched bearing two free carpels each ending in its own style and stigma. One of the carpels is of normal size bearing sixteen ovules, while the other is about half the size bearing only eight ovules. This may probably be due to lack of adequate nutrition or due to its having developed from the left over residual meristem.

Collateral Vascular Bundles in Orchids

B. N. Mulay, T. K. B. Panikkar and M. K. Prasad, Birla College, Pilani, state that they have observed collateral vascular bundles in the terrestrial roots of certain Orchids like

Microstylis rheddi Nutt. and *Liparis atropurpurea*, Lindl. Details of this work will be published elsewhere.

Systematic Studies in Botany and Zoology

A conference to discuss the importance and need of systematists was organised by Dr. Waldo L. Schmitt, Head Curator, Department of Zoology, U. S. National Museum, at Washington in August 1952 on behalf of the Society of Systematic Zoology. It is intended to get the report of this Conference published in book form for the benefit of non-systematists. To make it more useful it is desired to cite instances of incidents of the practical application of systematics and taxonomic studies, particularly with a view to draw the attention and get proper recognition of Foundations and fund granting agencies towards this much neglected, though fundamentally important subject.

All workers in the systematics of botany and zoology are requested to send their suggestions, notes, references, etc., on the utilitarian aspect of systematics to Dr. S. L. Hora, Director, Zoological Survey of India, Calcutta, at their earliest. It is intended to collate information thus received upto January 5, 1955, and to forward it to the organisers of the Conference.

Refractories in Metal Industry

A symposium on 'Recent Trends in the Fields of Production Practice and Research and Testing of Refractories used in Metal Industry' will be held on 19-21 January 1955 at the National Metallurgical Laboratory, Jamshedpur. The following foreign scientists are presenting papers to the symposium: Dr. J. B. Austin, U.S.A.; Dr. J. W. White, England; Miss Louise Halm, France; Prof. Yamauchi, Japan; and Prof. Dr. H. Salmang, Netherlands. In addition to reading and discussion of technical papers, the following special lectures have been arranged: "Graphite" by Dr. K. S. Krishnan, Director, National Physical Laboratory of India, New Delhi, and "A Metallurgist looks at Refractories Research" by Mr. E. H. Bucknall, Director, National Metallurgical Laboratory.

Electric Power from Sea Water

The production of electric power by mixing fresh and salt water in the hydro-electric pile is discussed by R. E. Pattle in the October 2 issue of *Nature* (p. 660).

The osmotic pressure of sea-water is about 20 atmospheres so that when a river mixes with the sea, free energy equal to that obtainable from a waterfall 680' high is lost. There thus exists an untapped source of power which has not been noticed before. The British experiment put the osmotic pressure to work by separating alternate layers of salt and fresh-water by alternate basic and acidic membranes that incorporate ion-exchange resins. When such membranes separate salt solutions of different strengths, a potential difference appears. The membranes are connected in series. A hydro-electric pile of 47 pairs of membranes each 8 cm. square yielded a maximum of 15 mw. output power at 39° C. At low temperatures the internal resistance is higher and the power output is lower. The pile is therefore likely to be more successful in a warm climate. Whether the process will be economical probably depends upon the time it will run before the membranes need replacing and the interior needs cleaning.

X-Ray Microscope

The General Electric Co., U.S.A., has developed an X-ray microscope which is capable of wide use in medical science, biology and industry.

In the G.E. X-ray microscope, the X-ray source is only a fraction of a micron in diameter. This is achieved by focussing the electrons through two electrostatitc lenses, which are essentially doughnut-shaped metal rings to which voltage is applied. The magnified X-ray image thus obtained can be seen by the eye or photographed for permanent record. The instrument provides great stability for the longer exposures needed for high quality pictures, and is the first to employ a built-in camera that provides developed photographs immediately after a subject is exposed.

In the study of heredity with the tiny fruit-fly, only exterior changes in the insect can be easily observed, with ordinary microscopes, but with the X-ray microscope changes in the internal organs can be observed equally well and in three dimensions. In the study of alloys, plastics and composition rubber, the X-ray microscope shows the mixture of the materials and can identify them by their relative X-ray absorbing power.

Sterling P. Newberry, electron-optics engineer of the G-E General Engineering Laboratory at Schenectady, N.Y., was co-authored by Selby E. Summers, in the development of the instrument.

Scientific Liaison

It is now six years since the UNESCO set up the network of science co-operation offices at representative centres on the globe. With these offices, UNESCO has sought a new solution to the old problem of international scientific co-operation. Set up on an experimental basis, they are now a permanent element in the world's facilities for exchange of scientific information.

The story of this network and the results it has obtained is told in a new illustrated booklet, *Science Liaison*, published by UNESCO. The main task of UNESCO science co-operation offices at Montevideo, Cairo, Istanbul, Delhi and Jakarta, is to assist scientists in obtaining information and materials within a reasonable length of time and without wasted effort. In particular, the offices endeavour to provide scientists in under-developed regions with facilities to overcome the obstacles of which they have an inordinately large share.

Bulletin of CGCRI, Calcutta

The inaugural number of the *Bulletin of the Central Glass and Ceramic Research Institute*, Calcutta, has been published. The Bulletin is to be issued as a quarterly devoted to the cause of the advancement of glass, ceramics and allied sciences and industries. The Bulletin will contain discussions of important current topics relating to glass and ceramic industries, technical articles dealing with the scientific aspects of the manufacturing operations involved in industry, contributed articles from the representatives of producers and consumers of glass, enamels, pottery, etc., articles on production and quality control, short notes on important new developments in techniques of production, equipment, etc., statistical information, abstracts from technical journals dealing with these industries, news and reviews of books.

Articles of interest in the present number are: glass containers suitable for distilled water by Atma Ram, S. P. Krishnaswamy, (Late) P. Roy and S. Sen; 'Studies on Saggars' by Atma Ram, J. C. Banerjee and N. B. Chatterjee. The annual subscription of the Bulletin is Rs. 6. For copies apply to: Central Glass and Ceramic Research Institute, Jadavpur, Calcutta-32.

Bulletin of the C.L.R.I., Madras

The Technical Bulletin of the Central Leather Research Institute has hitherto been issued in cyclostyled form for private circulation and contained mostly abstracts of research publications on leather science. Since August, it is being issued in an enlarged and printed form, and will contain in addition to abstracts, research papers of the Institute and other articles on leather technology. Trade advertisements of interest to leather research workers and leather industry will also be a feature of the enlarged bulletin.

The inaugural number contains two articles, on "Some Aspects of Leather Manufacture" by B. M. Das, and "Acid Salt Ratio of Indian Tanstuffs" by J. C. Sen, besides classified abstracts and Science Notes and News. The Bulletin is a monthly, and copies of it may be ordered from the Director, C.L.R.I., Madras-20.

M. R. Nayar Memorial Fund

Funds are being raised for creating an endowment in the name of the late Dr. M. R. Nayar, Department of Chemistry, of the Lucknow University. An appeal for generous contribution is being made by the Nayar Memorial Fund Committee. Subscriptions to this fund may kindly be sent to: Sri. S. C. Varma, Honorary Treasurer, Nayar Memorial Fund Committee, Chemistry Department, Lucknow University, Lucknow.

Award of Research Degree

The Andhra University has awarded the D.Sc. Degree in Physics to Sri. K. Suryanarayana Rao for his thesis entitled "Certain Theoretical Studies in Complex Spectra and Rotational Analysis of Columbium Oxide Bands".

The Andhra University has awarded the D.Sc. Degree in Technology to Sri. A. Venkateswarlu, for his thesis entitled "Heat Transfer with and without Phase Change in Square and Rectangular Conduits".

The University of Poona has awarded the Ph.D. Degree in Geology to Shri B. G. Deshpande for his thesis entitled "Ground-water Resources of the Alluvial Tracts of Gujerath, Bombay State".

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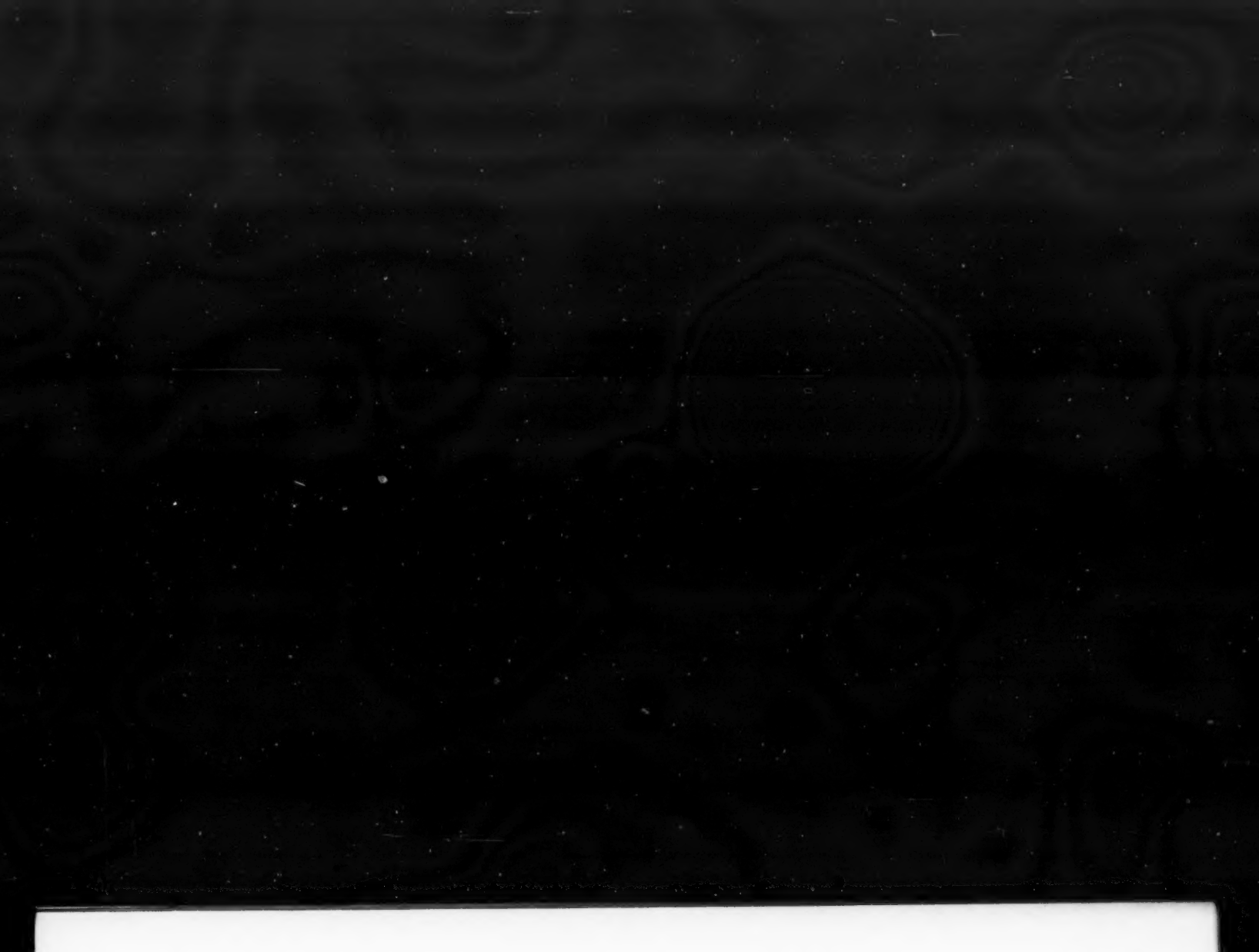
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